DISSERTATION ON

NEONATAL BEHAVIORAL ASSESSMENT AMONG SURVIVORS OF BIRTH ASPHYXIA USING T. BERRY BRAZELTON'S NBAS

Dissertation Submitted to

THE TAMILNADU DR. M.G.R. MEDICAL UNIVERSITY

In partial fulfilment of the regulations
For the award of the degree of

M.D IN PAEDIATRIC MEDICINE

BRANCH VII

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CERTIFICATE

I certify that the dissertation titled **"NEONATAL BEHAVIORAL ASSESSMENT AMONG SURVIVORS OF BIRTH ASPHYXIA USING T. BERRY BRAZELTON'S NBAS",** submitted by **Dr. RADHAKRISHNAN S.,** for the Degree of DOCTOR OF MEDICINE (PAEDIATRICS) (BRANCH VII), to The Tamil Nadu Dr.M.G.R. Medical University, Chennai, is the result of original research work undertaken by him in the Department of Paediatrics, Thanjavur Medical College, Thanjavur.

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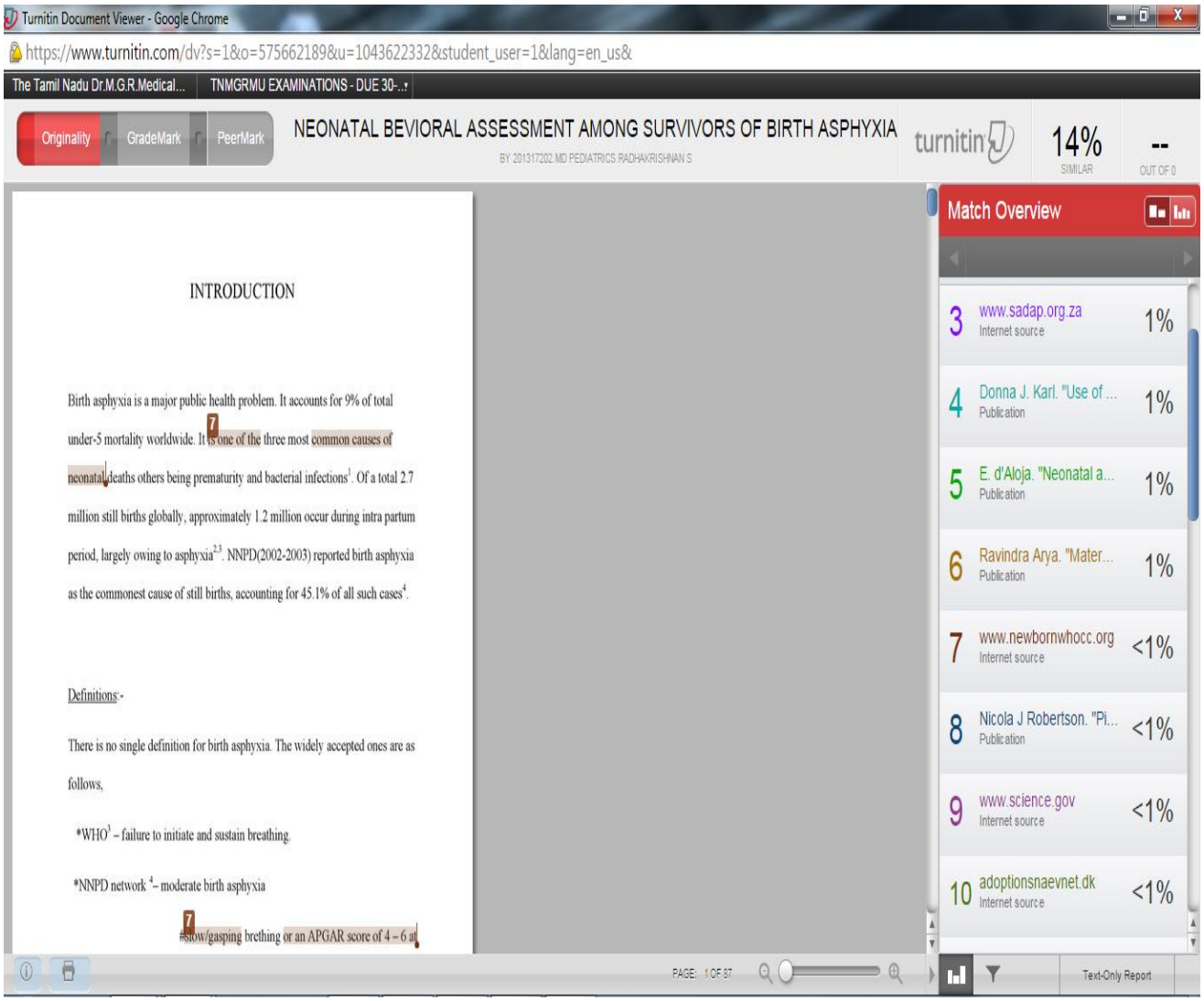
INTRODUCTION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INTRODUCTION
Birth asphyxia is a major public health problem. It accounts for 9% of total under-5 mortality worldwide. It is one of the three most common causes of neonatal deaths others being prematurity and bacterial infections[1]. Of a total 2.7 million still births globally, approximately 1.2 million occur during intra partum period, largely owing to asphyxia[2,3]. NNPD(2002-2003) reported birth asphyxia as the commonest cause of still births, accounting for 45.1% of all such cases[4].
Definitions:-
There is no single definition for birth asphyxia. The widely accepted ones are as follows,
*WHO[3] – failure to initiate and sustain breathing.
*NNPD network [4]– moderate birth asphyxia
#slow/gasping brething or an APGAR score of 4 – 6 at
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I hereby solemnly declare that the dissertation titled "**NEONATAL BEHAVIORAL ASSESSMENT AMONG THE SURVIVORS OF BIRTH ASPHYXIA USING T. BERRY BRAZELTON'S NBAS**" has been prepared by me under the guidance of **PROF. DR. M. SINGARAVELU MD., DCH., DNB(peds)., MNAMS(Ped), FIAP** PROFESSOR AND HOD, DEPARTMENT Of PAEDIATRICS, THANJAVUR MEDICAL COLLEGE, THANJAVUR. This is submitted to THE TAMILNADU DR.M.G.RMEDICALUNIVERSITY, CHENNAI, in partial fulfilment of the requirement for the degree of DOCTOR OF MEDICINE (PAEDIATRICS) (BRANCH VII).

PLACE:

DATE: Signature

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I dedicate this study to **T. BERRY BRAZELTON** of Harvard medical school, Boston, USA. Without his pioneering efforts on the NBAS, I wouldn't have had this topic to work for.

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I also express my gratitude to the Ethical Committee for allowing me to conduct this study.

I am extremely thankful to **my parents** and to **my brothers** for their moral support during the study period.

From the point of inception about this study in my mind till the point of submission, if I could point out one person who stood by side to make everything possible, its my wife **Mrs. ABHINAYA RADHAKRISHNAN.**

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I am grateful to babies and their parents and I thank them for their active participation in the study. I thank my statistician **Mr. Jesus Raja** for his timely help in the field of statistics.

Finally , I pay my prayers to the Almighty God for His blessings and wishes and making me pursue the post-graduation in my field of interest.

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CONTENTS

ABSTRACT

Objective:

- To apply NBAS among the survivors of birth asphyxia who make it to discharge successfully.
- To compare the behaviour derailment among the survivors according to their HIE staging.

Methods:

56 birth asphyxia survivors were randomly selected during the study period (Mar 2015 – Aug 2015). They were separated into 3 groups as HIE stage 1, 2 and 3 based on Sarnat and Sarnat HIE staging. T.Berry Brazelton's NBAS was administered on those babies when they were fit for discharge from hospital. Final scores calculated using Lester's recoding and results compared.

Results:

- The average score of HIE 1 babies were 65.01%, HIE 2 babies were 58.01% and that of HIE 3 babies were 41.75%.
- 60% of HIE 3 babies made a score less than 40%. 73% of HIE 2 babies scored between 50 and 60%. 88% of HIE 1 babies scored between 60 and 70%.

- >50% of HIE 1 babies had abnormal reflex score less than 5 while >60% of HIE 2 babies scored between 6 and 10. HIE 3 were the worst to perform where 3 of 5 babies scored >11.
- Sex of the babies, their birth weight and the mode of delivery showed no statistical significance for comparing them against the final % scores.
- Lower final %scores were associated with higher abnormal reflex scores and vice-versa.

Conclusion:

- NBAS helps us to prognostigate a baby individually rather relying upon personal past experiences of the treating neonatologist or non-directive statistics.

Every birth asphyxia survivor needs to be administered NBAS before discharge from hospital. By identifying strengths, one can boost the mother's confidence in looking after her child and ease the parent-child relationship. By identifying weakness and concerns, one can refer the child for rehabilitation and further intervention as would be required.

Keywords: - BIRTH ASPHYXIA, NBAS, HIE PROGNOSIS.

INTRODUCTION

Birth asphyxia is a major public health problem. It accounts for 9% of total under-5 mortality worldwide. It is one of the three most common causes of neonatal deaths others being prematurity and bacterial infections[1]. Of a total 2.7 million still births globally, approximately 1.2 million occur during intra partum period, largely owing to asphyxia[2, 3]. NNPD (2002-2003) reported birth asphyxia as the commonest cause of still births, accounting for 45.1% of all such cases[4].

Definitions:-

There is no single definition for birth asphyxia. The widely accepted ones are as follows,

*WHO[3] – failure to initiate and sustain breathing.

*NNPD network [4]– moderate birth asphyxia

#slow/gasping breathing or an APGAR score of 4 – 6 at 1minute.

- Severe birth asphyxia

#no breathing or APGAR 0 – 3 at 1 minute.

* American academy of paediatrics/American college of obstetrics and gynaecology (1996)[5]

- Profound metabolic acidosis pH<7.0
- APGAR score <3 after 5 min
- Neonatal encephalopathy
- multiorgan system dysfunction
- Criteria suggestive of intrapartum timing.

* International cerebral palsy task force (1999)[6]

- Metabolic acidosis in early neonatal blood sample (pH<7.0 and base deficit>12mmol/l)
- Moderate or severe encephalopathy
- Cerebral palsy of spastic quadriplegia/dyskinetic type
- sentinel event
- Abrupt change in fetal heart rate
- APGAR score <6 beyond 5 minutes.
- Multisystem involvement
- imaging evidence.

* American college of obstetrics and gynaecology (2003)[7]

- Metabolic acidosis (pH<7.0 and base deficit >12mmol/l)
- Moderate or severe encephalopathy
- Cerebral palsy of spastic quadriplegia/dyskinetic type
- Exclusion of other etiologies of cerebral palsy
- sentinel event
- Abrupt change in fetal heart rate
- APGAR score <3 beyond 5 minutes
- Multisystem failure within 72 hrs of birth
- imaging evidence.

Hypoxic ischemic encephalopathy[8]:-

HIE is diagnosed by

^an abnormal neurologic examination on the first day following birth complicated by perinatal asphyxia

^seizures within first 24 – 48hrs of life

^multiorgan dysfunction

^burst suppression pattern on EEG

^need for positive pressure ventilation for >1min or first cry delayed >5minutes

^evidence of HIE changes in MRI brain imaging with DWI/MR spectroscopy

^exclusion of other causes of encephalopathy.

HIE is of prime concern while managing asphyxiated neonate as it can kill the baby and carries a potential to cause serious long term neuromuscular sequelae among Survivors.

Classification of HIE: based on severity HIE are classified in mild moderate and severe. The most widely accepted classifications are as follows

a) Sarnat and Sarnat classification[9]

	Stage I(mild)	Stage II(moderate)	Stage III(severe)
Consciousness	Hyperalert, irritable	Lethargic or obtunded	Stuporous, comatose

Neuromuscular control	Uninhibited, over reactive.	Diminished spontaneous movement	Diminished or absent spontaneous movement
Muscle tone	Normal	Mild hypotonia	Flacced
Posture	Mild distal flexion	Strong distal flexion	Decreased or absent
Stretch reflexes	Over reactive	Over reactive disinhibited	Decreased or absent
Segmental myoclonus	Present or absent	Present	Absent
Complex reflexes:	Normal	Suppressed	Absent
Suck	Weak	Weak or absent	Absent
Moro	Strong, low threshold	Weak, incomplete, high threshold	Absent
Oculovestibular	Normal	Over reactive	Weak or absent
Tonic neck	Slight	Strong	Absent

Autonomic function:	Generalized sympathetic	Generalized para sympathetic	Both systems depressed
Pupils	Mydriasis	Miosis	Midposition, often unequal; poor light reflex
Respirations	Spontaneous	Spontaneous: occasional apnea	Periodic; apnea
Heart rate	Tachycardia	Bradycardia	Variable
Bronchial and salivary secretions	Sparse	Profuse	Variable
GI motility	Normal or decreased	Increased, diarrhoea	Variable
Seizures	None	Common focal or multifocal(6-24hrs of age)	Uncommon(excluding decerebnration)
EEG findings	Normal	Early: generalized low voltage	Early: periodic pattern with isopotential phases

		slowing(continuous delta and theta)	
		Later : periodic pattern(awake):seizures focal or multifocal ; 1.0 – 1.5hz spike and wave	Later: totally isopotential.
Duration of symptoms	<24hrs	2- 14 days	Hours to weeks.
Outcome	About 100% normal	80% normal; abnormal if symptoms more than 5 – 7 days.	About 50% die. Remainder with severe sequelae

b) Levene staging[10]

Feature	Mild	Moderate	Severe
Consciousness	Irritable	Lethargy	Comatose
Tone	Hypotonia	Marked hypotonia	Severe hypotonia

Seizures	No	Yes	prolonged
Sucking/respiration	Poor suck	Unable to suck	Unable to sustain spontaneous respiration.

c) Thompson score[11]

Sign	0	1	2	3
Tone	Normal	Hypertonia	Hypotonia	Flaccid
Consciousness	Normal	Hyperalert/stare	Lethargic	Comatose
Fits	Normal	<3/day	>2/day	
Posture	Normal	Fisting, cycling	Strong distal flexion	Decerebrate
Moro	Normal	Partial	Absent	
Grasp	Normal	Poor	Absent	
Suck	Normal	Poor	Absent	
Respiration	Normal	Hyperventilation	Brief apnea	Apneic
Fontanel	Normal	Full, not tense	Tense	

Max score is 22 which the worst. A score >15 is associated with abnormal outcome at 12 months of age.

Prognosis/outcome: - Neonatal morbidity index[12]

	0	1	2	3
5" APGAR	>6	5 -6	3 – 4	0 – 2
Base deficit(mEq/l)	<10	10 – 14	15 – 19	>19
FHR trace	Normal	Variable deceleration	Late	Bradycardia, deceleration

NMI <3: least risk. More the NMI scores higher the risk of death.

The overall mortality[13] is 20% and the possibility of sequelae[13] among survivors is 30%. The risk of cerebral palsy[13] in survivors of birth asphyxia is 5 – 10%. According to sarnat and sarnat staging, HIE 1[13] has mortality <1% and 98 – 100% have normal neurological outcome. HIE 2[13] babies pose a risk of death/ abnormal neurological outcome in the range of 20 – 37%. In HIE 3[13] death is more likely and survivors can have a major disability.

The brave survivor:-

After numerous pricks and various painful lifesaving procedures and supportive care, the unfortunate asphyxiated baby fortunate enough to make it, reaches

his/her parents. And there comes a key question to be answered – will my baby be neurologically normal? The answer, at most instances, is based on personal past experience of the treating neonatologist and the non-directive statistics mentioned previously.

In order to make a prognosis specific to each birth asphyxia survivor, a much more detailed scoring system would be necessary. Thats where T.Berry Brazelton's NBAS comes to rescue.

NBAS (Neonatal Behavioral Assessment Scale) :-

Earlier it was thought, babies were passive recipients of sensory stimulation, responding to environmental input with innate reflexes. In other words, newborn babies were just "lumps of clay" ready to be shaped by the environment based on their genetic potential.

NBAS assumes that the newborn is a social organism, predisposed to interact with her caregiver from the beginning and be able to elicit the kind of caregiving necessary for her species specific survival and adaptation[14.] NBAS describes the full range of neonatal behaviour including competencies and strengths as well as identifying areas of difficulty or deviation.

NBAS is a neurobehavioral assessment scale which is designed to describe neonates' responses to their new extra-uterine environment and to document the contribution of the newborn baby to the development of the emerging parent-child relationship.

So the study was designed to objectively document the behaviour pattern of birth asphyxiated babies and to assess how worse the behaviour is derailed according to the severity of HIE.

REVIEW OF LITERATURE

NBAS is a research tool used extensively by many researchers across the globe. Some of the pioneer studies are as follows,

Black et al[16](1993) and Lester et al[17](1998) have demonstrated the effects of maternal substance abuse on infant behaviour and development using NBAS. Subtle and less subtle effects were reported with concerns regarding neurobehavioral impairment and increased risk of learning difficulties.

The effects of prenatal cocaine use on the neurobehavioral outcomes of infants using NBAS was done by Eyler et al[18](1998). The amount and timing of cocaine use was found to be significant and for the later 3rd of gestation was found to be negatively related to orientation, alertness and cost of attention scores.

A similar study on antenatal cocaine abuse in infants' behaviour was also done by Morrow et al[19](2001).

Mansi et al[20](2007) looked at the effect of maternal smoking in pregnancy. Babies of smoking mothers demonstrated lower scores in many NBAS items and a strong correlation was found between infant irritability and urinary cotinine in newborns. Babies' irritability also correlated with the number of cigarettes smoked daily and the daily intake of nicotine. Paternal smoking also significantly correlated with infant urinary cotinine and infant irritability.

Oberlander et al[21](2010) studied the effect of prenatal alcohol on babies' behaviour. The study reported a blunted response to noxious stimulus among the exposed babies in terms of lower heart rate and reduced cortisol levels. There was a lower level of behavioural arousal on the NBAS assessment. A point to be noted

is that Mansi et al and Oberlander et al had a sample size of 25 and 28 respectively.

Stewart et al[22](2000) and Young et al[23](2005) demonstrated the effects of antenatal exposure to organophosphate pesticides and polychlorinated biphenyls. The newborns that were evaluated showed abnormal motor behaviour and reflexes.

Engel et al[24](2009) studied the effect of antenatal phthalate exposure from plastics in many consumer products and newborn behaviour. An interaction was found between sex of the baby and phthalate metabolites. Girl babies showed poorer orientation and levels of alertness while boy babies showed improved motor performance.

Oyamede et al[25] (1994) studied the effect of various antenatal factors on newborn behaviour. A significant relationship between maternal nutrition during pregnancy and infant behaviour was suggested. Cuco et al[26] (2005) demonstrated that intake of vitamins B1 and B6 in the 6th week of gestation and of iron in 38th week was found independently to have a positive and significant effect on the mototr cluster of the NBAS. This concludes that intake of B1, B6 and iron during pregnancy might contribute to the neuromotor maturity of the newborn.

Wolf et al[26] (2002) showed that VLBW babies differed from term babies on all clusters and supplementary items of NBAS, and showed more signs of stress, followed by continuing problems with self regulation.

Escher-Graub and Fricker [27](1986), Paludetto et al[28] (2002), Mansi et al[29] (2003) have worked on babies with hyperbilirubinemia and their behaviour using the NBAS. Escher showed that jaundiced babies had differences in aspects of habituation, orientation, motor performance, state regulation and autonomic stability. Paludetto showed effects were seen at 3days of moderate hyperbilirubinemia; 24hours later there were improvements and after 3 weeks no differences were seen between the affected and the non-affected group. Mansi showed that even 'safe' hyperbilirubinemia can be associated with potential altered neonatal behaviour.

Hart et al[30](2003) showed that breastfed infants were able perform better in orientation, motor, and state regulation items of the scale when compared to forula-fed babies. Breastfed babies also showed only fewer abnormal reflexes, signs of depression amd withdrawal. Hart et al[31](2006) also showed that babies receiving higher DHA were able to maintain optimal arousal.

Boatella-Costa et al[32](2007) demonstrated differences in behaviour between boy and girl babies. Girls have higher scores on orientation items, alertness and state regulation while boys scored higher on irritability.

Wittels et al[33](1997) studied the effect of maternal analgesia for pain relief after cesarean section on newborn behaviour. He showed that intravenous patient controlled analgesia with pethidine is associated with more neonatal neurobehavioral depression than patient controlled analgesia with morphine. Even with small doses used, morphine exposed babies were able perform better than those babies exposed to pethidine.

A stunning example to show the versatility of NBAS is cross species comparison study. Redshaw[34](1989) compared term gorilla, chimpanzee and orang-utan behaviour with that of term human infants after normal delivery and no medication for pain relief. Differences were seen in tone and in crying. But the orientation items were scored similarly.

Tronick[35](2007) showed that by using NBAS at 2-3 weeks of age it's possible to say if the baby's mother is depressed or not. A baby whose mother is depressed will not make proper eye contact, may even avoid gaze and may exhibit distress by spitting up during interactions with mother. The baby will be withdrawn unless the mother's depression is addressed to. Once the mother recovers the baby can be engaged more easily.

AIM OF THE STUDY

- To apply NBAS among the survivors of birth asphyxia who make it to discharge successfully.

- To compare the behaviour derailment among the survivors according to their HIE staging.

METHODS AND MATERIALS

Materials required – NBAS testing kit. (Available at http://www.brazelton-institute.com/order.html). The kit consists of a red ball, a rattle, a bell, a foot

probe and a torch. Not necessarily the Brazelton institute's kit, even the constituents assembled separately shall work fine for applying the NBAS.

Data collection: - 56 birth asphyxia babies, who were fit for discharge after intensive care treatment, were randomly selected during the study period (Mar 2015 – Aug 2015). Birth asphyxia survivors with associated co-morbidities like sepsis, jaundice, congenital anomalies, and preterm were excluded from the study as they themselves might influence upon the NBAS scores. The selected babies were grouped into 3 groups based on sarnat and sarnat[9] HIE staging as HIE 1(mild), 2(moderate), 3(severe). Babies were examined midway between feedings in a quit semi-darkened room with a room

temperature around 22 – 27^{0}C in the presence of the infants' mother. The optimal day of administering NBAS for the 1st time in any infant is the 2nd or 3rd day of life. It is also equally important to consider that NBAS should not be attempted for babies undergoing treatment in NICU with multichannel monitoring, IV fluids, oxygen etc. A baby who is either immature or recovering from illness may become over-stressed by the examination. Hence the examination was done only when the selected babies were ready for discharge from the hospital. NBAS was then applied and final scores calculated using Lester's seven cluster scoring system which is explained later in this section. The scores between the groups compared.

The administration of NBAS[14]:-

NBAS consists of 28 behavioral items (scored on a 9 point scale), 7 supplementary items (scored on a 9 point scale) and 18 reflex items (scored on a 4 point scale).

These items are grouped into 5 packages viz, the habituation package, the motor-oral package, the truncal package, the vestibular package and the social interactive package.

The administration of the NBAS begins with observation of the initial state. The baby could be in one of the 6 states – state 1 deep sleep; state 2 light sleep;

state 3 drowsy; state 4 alerts; in state 5 the baby has considerable motor activity; and state 6 which is crying.

a) Habituation package:

The items in this package are designed to evaluate the infant's capacity to shut out the negative stimuli. One of the most impressive mechanisms in the neonate is the capacity to decrease responses to repeated disturbing stimuli. It includes the response decrement items. To begin this package the baby should be in a sleeping state. If not, the examination was delayed until the baby assumes a sleep state (state 1 or 2).

1) Response decrement to light: light is shone directly into the baby's eyes for 1 – 2 seconds and response observed. Once response disappears and after 5 seconds, light is shown again. The cycle is repeated for a total of 10 times or until 'shutdown' is achieved. [With response decrement to light, rattle and bell, 2 non-responses are the criterion for shut down. With response decrement to tactile stimulation of foot only one non-response is the criterion for shutdown].
2) Response decrement to rattle: rattle is shaken 3 times, 25 – 30 cms away from the baby's ear and response observed. Once response disappears and after 5 seconds, rattle sound is presented again. The cycle repeated for a total of 10 times or until 'shutdown' is achieved.

3) Response decrement to bell: same as above. Except that a bell is used for a rattle instead.
4) Response decrement to tactile stimulation of the foot: the baby's foot is probed with a heel probe gently and response observed. Once response disappears and after 4 seconds, heel probe stimulus is given again repeating the same for a maximum of 5 times on one foot or until 'shutdown' is achieved.

b) The motor- oral package

This package contains minimally intrusive items which includes reflexes of the feet and rooting, sucking and glabella items.

1) Plantar reflex: ball of foot is pressed with the thumb. Flexion of toes and relaxation is expected. Other foot is also checked.
2) Babinski response: outside of the sole of foot is stroked. Expected response is dorsiflexion of big toe, with spreading of other toes.
3) Ankle clonus: sole of foot is pressed abruptly against the leg. The number of resisted beats of the foot is looked for.
4) Passive tone in legs: both legs are held around the knees and ankle. The legs are pulled back and forth once or twice through the full range of motion. The legs are extended and released. The quality of elasticity in tone is looked for in terms of resistance and the amount of recoil.

5) Passive tone in arms: arms are extended and pulled alongside trunk. Arms are released and looked for recoil.
6) Rooting response: corners of the mouth are gently stimulated. Expected response is head turning to the stimulated side and opening of mouth.
7) Sucking reflex: gloved index finger is inserted into the baby's mouth with pad toward palate. Closure of mouth, stripping action of tongue and a good suck are expected.
8) Glabella response: a brisk tap on forehead brings about a brief, tight closing of eyes.

c) The truncal package: this package includes the moderately stimulating items. They are
1) Palmar grasp: index finger or thumb is placed into the baby's hand and palmar surface is gently pressed to look for the hand grasp.
2) Pull-to-sit: the baby is held in his hands and forarms and slowly pulled to a seated position. The amount of head lag and the tone in neck and shoulders are looked for.
3) Placing reflex: baby is held by his chest, body facing away. One foot is tucked up and the dorsal part of the other foot is stroked by placing it under the protruding edge of the examining table. Expected response is foot lifting, toes fanning and foot moving downward on to the surface. Reflex tested on the other foot as well.

4) Standing reflex: baby is held upright under his arms and his feet are brought to touch the surface. The baby's ability to support his weight is looked for.
5) Walking reflex: moving on smoothly from standing, the infant's trunk is tilted forward to simulate stepping movement.
6) Crawling reflex: the baby is placed prone on his stomach with arms by the side. Freeing of face and spontaneous crawl is looked for. If crawl is not spontaneous, thumbs are pressed against the soles of feet to stimulate the response.
7) Incurvation reflex: infant is held across the examiner's hand with baby facing down and limbs hanging free. With index finger tap with quick, deep movements from below shoulder to buttocks. Swing or curving of trunk is looked for.
8) Tonic deviation of head and eyes, nystagmus: the baby is held face to face and slowly rotated through 90^0 in one direction. Head is repositioned to midline and repeated in the other direction. The position of the eyes during and the end of spin is noted. Also a slow nystagmus of each eye as it catches the light.
9) Cuddliness: the baby is held passively in the examiner's arms (horizontal) and then on the shoulders (vertical). The ability of the baby to actively mold into the examiner's holding position is looked for.

d) The vestibular package: this includes the maximal handling and stimulating items. They are

   1) Defensive movement: with baby in supine position, a cloth is used to cover the baby's eyes (nose should be free) and observed. The baby is expected to rooting head turning and neck stretching, directed and non directed swipes.

   2) Tonic – neck reflex: with the baby in supine position, the head us turned passively on one side and held in that position for 3 seconds. Expected response is to extend the extremities on the side of face and flex the extremities on the opposite side. The full fencer like position may not be always present in newborns. An increase in extensor tone on the face side and an increase in flexor tone on the skull side is expected.

   3) Moro reflex: the baby is lifted supine with one hand supporting the trunk and the other hand supporting the head. The head is flexed passively to bring the chin touch the chest. Head is abruptly dropped to a distance of 3inches and hand is kept in position to protect head.

e) The social interactive package: it includes all the orientation items. They are

   1) Animate visual – baby is held face to face at an angle of 45^0. Eye contact is made. Examiner slowly moves to one side in a horizontal 30^0 arc looking for if the baby is able to follow. If the baby follows for 30^0, the

same is tried with a 60^0 and 180^0 arc. Animate visual orientation is then tried on the other side as well.

2) Animate visual and auditory – the same technique as above is used. But along with face, examiner's voice is also presented to the baby.
3) Inanimate visual – the same technique as animate visual is applied. But a bright red ball is used, for a face instead. Care is taken not to distract the baby with examiner's face or voice.
4) Inanimate visual and auditory – same technique as for the animate visual and auditory item. Here a rattle is used, not the examiner's face and voice.
5) Animate auditory – the baby is held in midline and the examiner has to talk to the baby in soft low pitched voice without presenting the face to baby's field of vision. Care is also taken so that voice presentation is neither over-whelming, nor habituating. The baby's attempt to locate the voice is looked for.
6) Inanimate auditory – same technique as above. But not the voice, a rattle is used instead.

While administering NBAS, its highly possible that the baby can reach state 6, that is, crying (for at least 15 seconds). So the "consolability" of the baby is also assessed. It is assessed by administration of the consoling maneuvers :-

^ Self quieting

^ presenting face alone

^ Face and voice

^ Face, voice and hand on baby's belly

^ Face, voice, restraining both arms on chest

^ Face, voice, restraining arms, picking up and holding horizontally

^ Face, voice, restraining arms, holding and rocking

^ Face, voice, restraining arms, holding, rocking and swaddling

^ face, voice, restraining arms, holding, rocking, swaddling and pacifier.

Scoring the NBAS items[14]:-

For each item administered, scoring has to be done so that objective documentation of the baby's responses is possible. Refer to Annexure for NBAS scoring form.

RESPONSE DECREMENT TO LIGHT, RATTLE AND BELL (STATES 1, 2, 3)

Scoring

1. No shutdown observed and item has to be discontinued because baby moves into a crying state or exhibits signs of physiological stress, e.g. apnea, startles, tremors or severe cyanosis.
2. No shutdown observed, with a gradual increase in level of responsivity over the 10 trials. Startles may be present after the final trial.
3. No complete shutdown observed over 10 trials. Diminution in response does occur at some time during the 10 trial, but global responses return and are still present after the final trial.
4. No complete shutdown observed over 10 trials. Body movements are still present but there has been a decrease in the level of responsiveness over the 10 trials, with a gradual diminution from global to more minimal levels of responsiveness. Body movements may be delayed, and the infant is able to shut out completely at least once during the sequence, but is unable to reach the criterion by shutting out twice in succession.
5. Shutdown of body movements; some diminution of blinks and respiratory changes after 9-10 presentations of the stimuli.
6. Shutdown of body movements; some diminution of blinks and respiratory changes after 7-8 presentations of the stimuli.
7. Shutdown of body movements; some diminution of blinks and respiratory changes after 5-6 presentations of the stimuli.
8. Shutdown of body movements; some diminution of blinks and respiratory changes after 3-4 presentations of the stimuli.

9. Shutdown of body movements; some diminution of blinks and respiratory changes after 1-2 presentations of the stimuli.

RESPONSE DECREMENT TO TACTILE STIMULATION OF THE FOOT

Scoring

1. No shutdown and item has to be discontinued because infant moves into crying state or exhibits signs of physiological stress, e.g. apnea, startles, tremors or severe cyanosis.
2. No shutdown and response is generalized to whole body and increases over trials.
3. No shutdown over the 5 trials; body movements still present.
4. No shutdown after 5 trials, but a decrease in responsivity over the 5 trials is observed, with a gradual diminution from generalized body movements to minimal levels of responsivity.
5. Response localized to stimulated leg after 5 trials. No movement is observed in rest of the body.
6. Response localized to stimulated foot after 5 trials. No movements observed in rest of the body.
7. Complete shutdown after 5 trials.
8. Complete shutdown after 3-4 trials.
9. Complete shutdown after 1-2 trials.

INANIMATE AND ANIMATE VISUAL (AND VISUAL AND AUDITORY) ORIENTATION (ALERT STATES)

Scoring

1. Does not focus on or follow stimulus.
2. Stills with stimulus and brightens.
3. Stills, focuses on stimulus when presented, little spontaneous interest, brief following.
4. Stills, focuses on stimulus, and follows for a 30-degree arc, jerky movements.
5. Focuses and follows with eye horizontally for at least a 30-degree arc. Smooth movement, loses stimulus but finds it again.
6. Follows for two 30-degree arcs with eye and head. Eye movements are smooth.
7. Follows with eyes and head at least 60 degrees horizontally, maybe briefly vertically, partly continuous movement, loses stimulus occasionally, head turns to follow.
8. Follows with eyes and head 60 degrees horizontally and 30 degrees vertically.
9. Focuses on stimulus and follows with smooth continuous head movement horizontally and vertically, and follows in a circular path for a 180-degree arc.

INANIMATE AND ANIMATE AUDITORY ORIENTATION (ALERT STATES)

Scoring

1. No reaction.
2. Respiratory change or blink only.
3. General quieting as well as blinking and respiratory changes.
4. Stills, brightens, no attempt to reach for source.
5. Shifting of eyes to sound, stills and brightens.
6. Alerting and shifting of eyes, head turns to source.
7. Alerting, head turns to source, searches for, finds and looks at stimulus (at least once).
8. Alerting, head turns, eye search for and find stimulus repeatedly (3out of 4 times).
9. Alerting prolonged and consistent, head turns, eyes search for and find stimulus every time (4 times out of 4).

ALERTNESS (STATE 4)

This is a summary score interpreted by the examiner based on the baby's responses to the orientation items.

Scoring

1. Inattentive-rarely or never responds to stimulation.
2. When alert, responsiveness very brief and always delayed. Not specific to stimuli.
3. When alert, responsiveness brief and often delayed and quality of alertness variable. Responsiveness specific to stimuli.
4. When alert, responsiveness brief but not delayed. Quality of alertness variable.
5. When alert, responsiveness of moderate duration. Responsiveness may be delayed and variable and it may take considerable time to engage to infant's alertness.
6. When alert, responsiveness of moderate duration, not delayed and not variable and can be achieved with minimal examiner effort.
7. When alert, responsiveness of generally sustained duration. Still some delay and variability. Examiner support may be necessary to elicit this level of responsiveness.
8. When alert, responsiveness is sustained. No delay or variability, and minimal examiner support necessary to initiate orientation responses.
9. Always alert for most of the examination. Orientation cues are clear and alertness predictable. No examiner facilitation necessary.

GENERAL TONE (STATES 4, 5)

This is a summary assessment of the overall tone as the baby responds to being handled. Its assessed when the baby is in state 4 or 5 and not when the baby is sleeping or crying.

Scoring

1. Flaccid, limp like a rag doll, no resistance when limbs are moved, complete head lag in Pull-to-Sit.
2. Some slight response felt as the infant is moved, but is observed less than 25 percent of the time.
3. Flaccid, limp most of the time, but its responsive about 25 percent of the time with some tone.
4. Some tone half the time, responds to being handled with average tone less than half the time.
5. Tone average when handled, lies with relaxed tone at rest.
6. Responsive with good tone as infant is handled approximately 75 percent of the time, may be on the hypertonic side up to 25 percent of the time, variable tone in resting.
7. Is on the hypertonic side approximately 50 percent of the time.
8. When handled, infant is responsive, with hypertonicity about 75 percent of the time.
9. Hypertonic all the time.

MOTOR MATURITY (STATES 4, 5)

Scoring

1. Cogwheel- like jerkiness, overshooting of legs and arms in all directions.
2. Jerky movements predominate with mild overshooting.
3. Jerky movements predominate, with no overshooting.
4. Jerky movements half the time, smooth movements half the time.
5. Smooth movements predominate (about 75 percent of the time), some jerkiness may be observed.
6. Smooth movements throughout, arcs predominately 45 degrees. There are no 90-degree angles. Jerkiness is no longer observed.
7. Smooth movements throughout, 90-degree arcs observed 25 percent of the time. No jerkiness observed.
8. Smooth movements throughout, 90-degree arcs observed 75 percent of the time. No jerkiness observed.
9. Smooth movements throughout, unrestricted smooth arcs of 90-degrees or more all of the time. No jerkiness observed.

PULL-TO-SIT (STATES 3, 4, 5)

Scoring

1. Head flops back completely, with no attempt to bring it up. No shoulder and neck tone observed.

2. Futile attempts to bring head forward to midline, but very slight shoulder tone increase are felt.
3. Increase in shoulder tone felt and infant is able to bring head forward through midline. Head remains forward, resting on chest, but infant is unable to bring it back to midline.
4. Some shoulder and arm tone increase is felt as infant is pulled to sit. Infant brings head through midline. Infant makes further attempts to bring head back up to midline, although does not succeed.
5. Head and shoulder tone increase is felt as infant is pulled to sit. Infant brings head through and then successfully brings it back to midline. Can imagine it there for at least 1-2 seconds.
6. Head and shoulder tone increase, and infant bring head to midline twice and can keep it in position at midline for 2 seconds or more.
7. There is still some head-lag as infant is pulled to sit. However, head can now be maintained at midline for a total of 10 seconds. When the head falls, the infant repeatedly rights it.
8. No head-lags observed as infant is pulled to sit. Infant can maintain head at midline for 10 seconds,
9. No head-lag. Shoulder and neck tone increase as infant is pulled to sit. Can maintain head at midline for 30 seconds.

DEFENSIVE MOVEMENT (STATES 3, 4, 5)

Scoring

1. No response.
2. General quieting.
3. Non-specific motor responses with long latency.
4. Non-specific motor responses with short latency.
5. Rooting and lateral head turning.
6. Neck stretching in addition to rooting, head turning and increased motor activity.
7. More than one non-directed swipe of arms in upper quadrant area of the body.
8. More than one directed swipe of arms in the upper quadrant, directed at the cloth.
9. Successful removal of the cloth with swipes.

ACTIVITY (STATES 4, 5)

There are two kinds of activity – spontaneous and elicited. Amount of activity is graded as much = 75% or more of the time, moderate = 50% of the time, slight = 25% of the time.

Scoring

Score spontaneous and elicited activity separately on a four-point scale: 0=none; 1=slight; 2=moderate; 3=much. Then add up the two scores.

1. Total score = 0.
2. Total score = 1.
3. Total score = 2.
4. Total score = 3.
5. Total score = 4.
6. Total score = 5.
7. Total score = 6.
8. Continuous but consolable movement.
9. Continuous, unconsolable movement.

PEAK OF EXCITEMENT (ALL STATES)

It's an overall amount of motor and crying activity observed during the course of examination. The examiner observes the baby's peaks of excitement and how he/she returns to a lower responsive state. When babies reached their peak of excitement, their intense reactions makes then unavailable to the outside world. That merits a high score. On the other hand, few babies' barley responds and their peak of excitement is low.

Scoring

1. Low level of arousal to stimulation. Never moves beyond State 2.

2. Some arousal to stimulation. Reaches State 3.
3. Infant is predominately in State 3 or lower but may reach State 4 briefly (for less than 15 seconds).
4. Infant is predominately in State 4 but may reach State 5 or 6 briefly (less than 15 seconds).
5. Infant is predominately in State 5 but may reach State 6 (for 15 seconds) once or twice during the examination.
6. Infant reaches State 6 more than twice during the examination, but returns to lower states spontaneously, at least twice.
7. Infant reaches State 6 more than twice, but with consoling is easily brought back to lower states.
8. Infant reaches State 6 more than twice but is consoled with difficulty. Usually needs pacifier or suck to be consoled.
9. Infant achieves insulated crying state. Unable to be quieted or soothed.

RAPIDITY OF BUILD-UP (ALL STATES)

How much stimulation causes the baby to loose control and the point during the examination at which this occurs – is rapidity of build up.

Scoring

1. Never cries throughout the examination.

2. Does not cry until the end of the examination, i.e. after the Moro Reflex.
3. Does not cry until after examination of tonic deviation of Head and Eyes, Defensive Movements or Tonic Neck Reflex.
4. Does not cry until Pull-to-Sit, Placing, Standing, Crawling/Walking or Incurvation.
5. Does not cry until being undressed.
6. Does not cry until Tactile Stimulation of the Foot or the foot reflexes.
7. Does not cry until uncovering and being placed in supine.
8. Does not cry during the response decrement items.
9. Never was quiet enough to score this.

IRRITABILITY (AWAKE STATES)

The number of items in the following list which makes the baby responds with an audible fussing or crying for at least 3 seconds. Uncover/place in supine; response decrement to tactile stimulation of the foot; undressing; passive tone in legs and arms; pull-to-sit; place in prone; defensive movements; tonic neck reflex; moro reflex.

Scoring

1. No fusing to any of the above.
2. Irritable fussing to 1 of the stimuli.
3. Irritable fussing to 2 of the stimuli.

4. Irritable fussing to 3 of the stimuli.
5. Irritable fussing to 4 of the stimuli.
6. Irritable fussing to 5 of the stimuli.
7. Irritable fussing to 6 of the stimuli.
8. Irritable fussing to 7 of the stimuli.
9. Irritable fussing to 8 or more of the stimuli.

LABILITY OF STATES (ALL STATES)

This measures the baby's state behaviour over the examination period. Every definite state change over a recognizable period of at least 15 seconds is counted.

Scoring

1. 1-2 state changes observed over the course of the examination.
2. 3-4 state changes.
3. 5-6 state changes.
4. 7-8 state changes.
5. 9-10 state changes.
6. 11-12 state changes.
7. 13-14 state changes.
8. 15-16 state changes.
9. 17 or more state changes.

Babies with a score 1 – 3 are not very labile, 4-6 are of moderate lability and 7 or higher are assigned to babies who are very labile.

CUDDLINESS (STATES 4, 5)

Scoring

1. Always resists being held, continuously pushes away, thrashing or stiffening.
2. Resists being held most but not all of the time.
3. Neither resists nor participates, lies passively in arms and on shoulder (like a sack of meal).
4. Eventually molds into arm, but after a lot of nestling and cuddling by the examiner.
5. Usually molds and relaxes when held. Inconsistency between horizontal and vertical positions.
6. Always molds and relaxes when held.
7. Always molds, nestles head in crook of elbow and neck of the examiner.
8. Always molds initially. In addition to molding and relaxing, the infant nestles and turns head, leans forward on the shoulder, fits feet into cavity of other arm; all of body participates. Head nestles in crook of elbow and neck. Predictably turns toward body in horizontal and vertical positions.
9. All of the above and baby grasps and clings to the examiner.

CONSOLABILITY (STATE 6-4 OR LOWER)

Scoring

1. Not consolable.
2. Pacifier or finger to suck in addition to dressing, holding and rocking.
3. Dressing, holding in arms and rocking.
4. Holding and rocking.
5. Picking up and holding.
6. Hand on belly and restraining one or both arms.
7. Hand on belly held steady.
8. Examiner's voice and face alone.
9. Examiner's face alone.

If the baby is never upset it's marked as NA.

SELF-QUIENTING (STATE 6-4 OR LOWER)

Scoring

1. Makes no attempt to quiet self, intervention always necessary.
2. A brief attempt to quiet self (less than 5 seconds) but with no success.
3. Several attempts to quiet self, but with no success.

4. One brief success in quieting self for period of 5 seconds or more.
5. Several brief success (5 seconds) in quieting self.
6. An attempt to quiet self which results in a sustained successful quieting with the infant returning to State 4 or below for at least 15 seconds.
7. One sustained (15 seconds) and several brief successes (5 seconds) in quieting self.
8. At least two sustained (15 seconds) successes in quieting self.
9. Consistently quiets self for sustained periods, never needs consoling.

HAND-TO-MOUTH (ALL STATES)

A hand-to-mouth reflex is inborn. It can be triggered by mucus or gagging or by discomfort.

Scoring

1. No attempt to bring hand to mouth.
2. Brief swipes at mouth area, no contact.
3. Hand or fist bought next to mouth once, contact made but no insertion.
4. Hand or fist bought next to mouth twice, contact made but no insertion.
5. Hand or fist bought next to mouth at least three times but no insertion.
6. One insertion of the hand or fist with brief sucking attempts, unable to be maintained.

7. Three or more brief insertions with brief sucking attempts, with at least one maintained for more than 3 seconds.
8. Sustained sucking on hand or fist observed on several occasions, each lasting more than 3 seconds.
9. Sustained sucking on hand or fist observed on several occasions, with at least one lasting over 15 seconds.

TREMULOUSNESS (ALL STATES)

A measure of central nervous system irritation or depression, immaturity. Some tremor of the extremities can be expected in the first week of life. Tremor of the chin seen during crying is not counted. Tremors may normally be seen during sleep.

Scoring

1. No tremors or tremulousness noted.
2. Tremors observed only in States 1, 2 or 3.
3. Tremors only after the Moro reflex or startles.
4. Tremulousness seen once or twice in States 5 or 6.
5. Tremulousness seen three or more times in State 5 or 6.
6. Tremulousness seen once or twice in State 4.
7. Tremulousness seen three times in State 4, fewer than three times in other states.

8. Tremulousness seen more than three times in State 4 and may be seen more than three times in each if the other states.
9. Tremulousness seen consistently and repeatedly in all states.

STARTLES (STATES 3, 4, 5, 6, EXCLUDING THE RESPONSE OF DECREMENT ITEMS)

Abnormally sensitive infants overreact to any disturbing stimulus with a startle and have observable startles for no observable reason.

Scoring

1. No startles noted.
2. Startle as a response to the examiner's attempt to elicit a Moro reflex only.
3. 2 startles, including Moro.
4. 3 startles, including Moro.
5. 4 startles, including Moro.
6. 5-6 startles, including Moro.
7. 7-9 startles, including Moro.
8. 10 startles, including Moro.
9. 11 or more startles, including Moro.

LABILITY OF SKIN COLOR (ALL STATES)

Change in colour which occurs during the examination period. Abnormal colour may be the result of overstressed or depressed autonomic system.

Scoring

1. Pale, cyanotic skin colour, remaining so during the course of the examination.
2. Pale or cyanotic skin colour at the outset which improves minimally during the examination.
3. Pale, cyanotic skin colour through most of the examination but improvement is seen during the course of the examination.
4. Healthy colour predominates but acrocyanosis in the extremities as well as the chest or abdomen is observed. Mild cyanosis around the mouth or extremities may also be observed.
5. Healthy colour throughout with slight paling observed on parts of the body after stress during the examination. Good colour returns spontaneously.
6. Healthy colour predominates, but a complete change in colour to red, which extends over the whole body, may be observed. Good colour returns quickly with soothing or covering.
7. Colour changes to very red when stressed and extends over the whole body. Recovers healthy colour slowly if coloured or soothed.
8. Baby becomes very red early in the examination, and recovery is slow.
9. Baby is markedly red throughout the examination. Good colour rarely observed.

Here in this scoring, the midpoint is the healthy colour. 1-3 describes the pale cyanotic colour and score 7-9 describes more of plethora.

SMILES (ALL STATES)

Scoring

- Record the number of times a smile is observed.
- Leave blank if no smile is observed.

SUPPLEMENTARY ITEMS

These are summary items which describe the more qualitative aspects of the baby's performance over the course of examination and to capture the more subtle signs of stress that may not be captured by the standard scale items described above. Though it's optional to score these, it is recommended in high risk babies.

QUALITY OF ALERTNESS

It is a summary score describing the overall quality of baby's responsiveness through the course of examination. It helps to discriminate between low level, dull, vague, uninvested alertness and open-eyed 'processing' alertness, characterized by widening and brightening of eyes, focusing of eyes on the stimulus, and pursing of lips, often with raised eyebrows.

Scoring

1. No State 4 is achieved during the examination, despite examiner's best efforts.
2. Infant is dully alert with only fleeting eye attention, facial changes and body stilling. Despite examiner's best efforts, attempts at responsiveness are dull and fleeting but do seem to be responsive, however briefly, to the stimuli.
3. Infant is capable of brief periods of bright alertness, with a great deal of examiner facilitation. These periods last for less than 5 seconds and even when the baby either becomes hyper alert, with wide staring eyes and tense body tone, or close her eyes and returns to a lower unavailable state. Either of these transitions may be accompanied by colour change, tremors or startles. This hyper alert look, although apparently focused on the stimulus, gives the appearance of the infant being 'locked on' to the stimulus but the examiner is unable to break through the intensity of the infant's gaze.
4. Infant is capable of brief periods of bright invested alertness, with moderate support from the examiner. These periods last for at least 5-10 seconds, and are invested in the stimulus, but stop when the infant turns away, returns to a lower state or becomes more active, hyperalert or fussy.
5. The infant's alert responsive behaviour, characterize by a focused gaze, brightening of the eyes and stilling of body movements, now lasts for at least one period of 15 seconds. These behaviours are still moderately

difficult to bring about, but they are clear and cease when the baby either turns away with dull staring or becomes more active and hyperalert.

6. Alert periods as above are present and last for at least two moderate periods of 15 seconds. These periods are achieved with minimal examiner facilitation. The infant does not need to shut out so quickly. Eyes may still wander off and on, and there may still be overshooting of eye movement in response to the stimulus.
7. The infant is capable of repeated periods of alertness of moderate duration during the course of the examination. Her eyes are bright, she is able to focus, the head and eyes are coordinated and she is able to maintain quiet alertness without any help from the examiner. These periods may be terminated by restlessness or crying, by dull gaze or staring, but the infant can easily be brought back to quiet available alertness by the examiner.
8. Alert periods, with entire face and head participating, are prolonged and last for more than 30 seconds each time. The infant can let go of the stimulus and with rest periods can return with ease with a brightened focused alert look.
9. Prolonged periods of alert behaviour dominate the infant's performance. Infant elicits stimulation and can modulate attention in and out with ease. Eye movements are always smooth and focused, head and eyes always coordinated. Infant maintains intense gaze on the stimulus and needs no examiner facilitation to achieve this level of responsiveness.

COST OF ATTENTION

NBAS is a stressful for babies. The stress can be manifested in one of the 3 systems viz, autonomic stress evidenced as abnormal colour/abnormal breathing pattern; motor exhaustion evidenced as abnormal tone, flailing; and state overloading characterized by crying, hiccups, yawns, regurgitating or gagging.

Scoring

1. The cost to the autonomic system is so great that the habituation items have to be discontinued. Paling or cyanosis, grunting or rapid breathing with periods of apnea register the cost to the infant's autonomic system.
2. The habituation package and the minimally stressful items of the Motor-Oral package can be administered, but signs of autonomic exhaustion, as described above, appear. The baby's colour and respirations can be maintained by the sensitive adaptations of the examiner, but the examination must be continued before the more moderately stimulating items or the orientation items can be maintained.
3. The first three packages of the examination can be administered before the autonomic system is so taxed that the examination must be discontinued. The infant is unable to respond to the orientation items without evidence of acute autonomic stress.
4. Although all the examination can be completed, the cost to the baby is extremely high, as represented by the level of behavioural disorganization

and stress in the autonomic, motor and state systems. No orientation responses are available. Halfway through the examination, one of these systems demonstrates the cost: (i) motor behaviour becomes disorganized as manifested by changes in the quality of tone, or activity levels; (ii) the infant's states become disorganized, as manifested by rapid state changes, heightened irritability and loss of state control; (iii) mild acrocyanosis or increasing respiratory rate heralds infant's impending stress.

5. The examination can be completed, including some of the orientation items. The baby maintains stability over the first two-thirds of the examination, but towards the end instability appears in one of the three systems described above.
6. The baby can be examined without any deterioration in state organization during most of the examination. However at the end of the examination, the infant is quite disorganized, as demonstrated by instability in any of the three sub-systems,
7. Although there may have been some evidence of stress during the examination, after the examination there is no longer evidence of any exhaustion, disorganization or instability in any of the sub-systems.
8. The baby's level of stress is minimal throughout the examination and stability and organization improves as the examination proceeds.
9. The baby's organization and responsiveness are not compromised from the beginning to the end of the examination. Autonomic stability, motor

organization and state regulation are enhanced by stimulation and handling throughout the examination.

EXAMINER FACILITATION

Examiner's help is necessary for baby's performance.

Scoring

1. Despite maximal efforts on the part of the examiner, responses cannot be elicited and examination has to be abandoned early.
2. With maximal efforts, such as swaddling, using a pacifier, long periods of rocking and containment, a few responses can be elicited that are scored.
3. With all the efforts described, a majority of responses can be elicited and scored successfully.
4. The infant can be managed throughout the examination, but with persistent efforts with rocking, containment and use of pacifier must be utilized all the way through. The baby repeatedly gets upset, goes to sleep or becomes limp, and repeated efforts must be made to enable her to respond.
5. The baby performs adequately throughout the examination, although the examiner must use one of the more maximal structuring maneuvers to establish testable behaviour organization.
6. Only moderate, and no maximal, controls are necessary to achieve behavioural organization; or initially it is difficult, and the baby needs

moderate controls, yet the baby improves over the examination and is relatively easy to work with at the end of the examination.

7. Mild visual, auditory and proprioceptive stimuli are all the examiner uses to keep the baby responsive throughout the examination. By the last half of the examination, no controls or effort on the examiner's part is necessary.
8. Visual and auditory stimulation are used to initiate the baby's responsiveness. The baby maintains alertness with mild stimulation continuously throughout the examination.
9. The baby is responsive to all presentations of items in the examination. No special efforts from the examiner are needed.

GENERAL IRRITABILITY

This measure of general irritability is not intended to replace the measure of irritability to specific stimuli.

Scoring

1. Irritable to all degrees of stimulation encountered throughout the examination.
2. Irritability begins early (somewhere around Uncovering, Tactile stimulation of the Foot or Undressing) and increases in frequency during

the course of the examination. Irritability commonly results in State 6 crying. Difficult to console.

3. Irritability to most of the items, both non-aversive and aversive, leading to State 6 crying. Difficult to console.
4. Irritability to some of the items, both non-aversive and aversive, leading to State 6 crying. Difficult to console.
5. Irritability to aversive and non-aversive stimuli, leading to State 6 crying, but with consoling the infant returns to lower states.
6. Irritability to aversive and non-aversive stimuli, leading to State 6 crying, but returns to lower states spontaneously.
7. Irritability to aversive and non-aversive stimuli, but control is regained easily. Fussing does not lead to State 6 crying.
8. Irritable only to aversive stimulation, but control is regained quickly.
9. No irritability; the infant responds to al stimuli with well-maintained self-control.

ROBUSTNESS AND ENDURANCE

This is based on the limited energy resources available with the babies who are recently ill and rest needed by them to complete the examination.

Scoring

1. Infant has no energy at all or appears very frail and the examination cannot be completed.
2. Infant's energies are very limited-she is quite frail and long rest periods are necessary; the examination has to be shortened.
3. Infant shows considerable exhaustion and frailty, yet with prolonged breaks and slowed timing the examination can be completed, although a few items must be deleted and scored NA.
4. Infant repeatedly shows evidence of exhaustion; she is moderately frail, but the examination can be completed, with some breaks.
5. Infant repeatedly shows evidences of tiredness and fatigue, or is somewhat frail, but with brief breaks can recover and finish the examination.
6. Infant is somewhat frail and halfway through the examination needs to be given breaks. She can recover with relative ease to complete the examination and seems somewhat organized at the end.
7. Infant is fairly robust and energetic throughout the examination and needs only minimal break because of diminishing energy resources; or she starts out somewhat frail but becomes more energetic and robust as she goes along. Organization improves as she is examined.
8. Infant may have brief period of mild exhaustion or minimal frailty in the beginning, but becomes quite energetic and robust as examination proceeds.

9. Infant is robust and has good energy resources throughout the examination. She performs with ease and shows no evidence of overloading or exhaustion.

STATE REGULATION

This is based on maturation and well being of the baby.

Scoring

1. Infant remains in unavailable states of crying and/or sleep for the course of the examination.
2. Infant is mainly in sleep but can come to State 3 on at least one clear occasion.
3. Infant is mainly in sleep states, including State 3, but has a brief period (5 seconds) in State 5.
4. Infant is mainly in sleep states, but may also move briefly into state 3 and 5 or 6. May exhibit low-level dull State 4 alertness.
5. Infant is mainly in stable stats 1, 2 and 3. May move into States 5 or 6 but is capable of brief alert State 4 or 5 seconds or less.
6. Infants has stable sleep states and has a robust well-defined State 5 and has State 6 available, although briefly. Capable of well-organized focused State4 lasting for more than 5 seconds.

7. Infant has State 4 available and can actively keep herself there for at least 15 seconds, with minimal excursions into States 5 or 6. Sleep and cry states are robust.
8. Infant need no support or minimal amounts of supports to maintain at least two prolonged periods of alert State 4 behaviour. The oscillations to other states may be abrupt or unmodulated but they do not interfere with the infant's ability to maintain several periods of alertness. Sleep states are well organised and crying is robust.
9. Infant has full range of organised states available with brief periods in State 3, 5 or 6. Infant can actively control herself in focused State 4 without stress and without any need of external supports from the examiner.

EXAMINER'S EMOTIONAL RESPONSE

As mentioned above NBAS is stressful for babies as prolonged periods of alertness are expected of them which is difficult in babies who are immature or recovering for illness. But, administering NBAS can be stressful for the examiner too.

Scoring

1. Extremely challenging examination, no rewarding behaviour observed; examiner relieved to be finished.

2. Very challenging examination; infant may emit brief rewarding period. Examiner has negative perception of the baby's behaviour.
3. Challenging examination with brief periods of rewarding behaviour. Examiner is left with a predominately negative opinion of the baby's behaviour.
4. Both rewarding and worrisome behaviour during the examination. Examiner has some concerns about the baby.
5. Rewarding and aversive behaviour observed equally during the examination.
6. Mostly rewarding, with periods of aversive behaviour, which are brief.
7. Rewarding behaviour throughout the examination but a few periods are unrewarding.
8. Moderately rewarding behaviour throughout the examination and the examiner has a positive response to the baby.
9. Very rewarding behaviour throughout the examination. The examiner has a very positive impression of the baby.

REFLEXES OR ELICITED RESPONSES

The responses are scored as follows:

0 Reflex not able to be elicited despite several attempts.

1 Hypoactive response

2 Normal response.

3 Hyperactive response

A Asymmetric response, either in terms of lateralization or segments of body. (Arms vs. Legs, etc.).

A score of 2 would be normal. Exception is ankle clonus, nystagmus and tonic neck reflex where 0, 1, 2 are normal and 3 would be considered abnormal.0

PLANTAR GRASP

0 Not present.

1 Weak, unsustained flexion of the toes.

2 Good sustained response.

3 Very strong, obligatory flexion of toes cannot be relaxed.

BABINSKI

0 Not present.

1 Week dorsal flexion, minimum spread of toes.

2 Good dorsal flexion with marked spreading of toes, including some flexion of great toe.

3 Obligatory, brisk dorsal flexion with obligatory spreading of toes; no relaxation afterward.

ANKLE CLONUS

0 No clonus.

1 One beat only.

2 Two or more beats; up to 4 or 5, if gradual increase in intensity.

3 More than 5 beats.

ROOTING

0 No lip or tongue movement

1 Only a weak turn or lip movement and/or slight tongue protrusion.

2 Turn to stimulated side; mouth opens and grasps; lips may curl to stimulated side.

3 Obligatory rooting, grimacing, with mouthing movements which do not subside.

SUCKING

0 No sucking movement at all.

1 Weak or barely discernible suction.

2 Modulated, rhythmic suck.

3 Exaggerated, obligatory suck which does not decrease over time.

GLABELLA

0 No reaction.

1 Weak; response barely discernible.

2 Modulated response.

3 Overly brisk closure of eyes and total facial grimace.

PASSIVE MOVEMENTS- ARMS

0 No resistance to extension and no recoil.

1 Little resistance to extension and weak recoil.

2 Moderate and modulated resistance to extension and good or moderate recoil.

3 Hypertonic resistance to extension and obligatory recoil with overshooting.

PASSIVE MOVEMENTS- LEGS

0 No resistance to extension and no recoil.

1 Little resistance to extension and weak recoil.

2 Moderate and modulated resistance to extension and good or moderate recoil.

3 Hypertonic resistance to extension and obligatory recoil with overshooting.

PALMAR GRASP

0 No grasping movement at all.

1 Short, weak flexion.

2 Strong, sustained grasp, relaxes at will.

3 Obligatory grasp, difficult to relax.

PLACING

0 No flexion or extension.

1 Minimal flexion and extension of knee and hip and/or foot after several attempts.

2 Modulated flexion of knee and hip, extension of foot.

3 Obligatory flexion and weight-bearing after first stimulus.

STANDING

0 No support by legs.

1 Minimal response felt; brief of transitory support.

2 Supports weight by extension of legs for at least 5 seconds.

3 Obligatory hyperextension of legs; no relaxation afterward.

WALKING

0 No hip or knee flexion at all.

1 Some indication of stepping action while slight hip or knee flexion.

2 Discernible steps with knee and hip flexion, step on each side.

3 Obligatory hyper-reactive response with hip and knee flexion and ankle extension.

CRAWLING

0 No freeing of face and no attempt to flex hip or knee.

1 Weak attempts to crawl, minimal action, minimal attempts to free face.

2 Coordinated crawling motion and freeing of face.

3 Obligatory crawling with arched back and hyper extended neck; no relaxation afterward.

INCURVATION (GALLANT RESPONSE)

0 No response.

1 Minimal incurvation movement.

2 Good incurvatiion, with hip swing.

3 Exaggerated response, with excessive and abrupt hip swing and no relaxation afterward.

TONIC DEVIATION OF HEAD AND EYES

0 No head or eye movement.

1 Weak, response barely discernible.

2 Good modulated response of head and eyes turning in direction of spin.

3 Immediate, obligatory head and eye turn, no return to midline after discontinuing the spin.

NYSTAGMUS

0 No saccadic movement.

1 1 or 2 saccades during rotation.

2 3 or 4 saccades per rotation.

3 Many sustained saccades per rotation with saccades persisting long after rotation has stopped.

TONIC NECK REFLEX

0 No adjustment of arms or legs.

1 Transient adjustment of arms or legs, not maintained.

2 Gradual, modulated adjustment of arms, legs, and trunk away from face side of head.

3 Obligatory response of arms, legs and trunk; no release of response.

MORO REFLEX

0 No response.

1 Weak response with minimal abduction of shoulders and extension of elbows and wrists; minimal extension of hips and knees.

2 As head is dropped, good abduction of shoulders and extension of elbows and wrists; extension of hips and knees followed by some beginning crossover of arms.

3 Obligatory, excessive abduction of shoulders and extension of hips and knees; no flexion, no readjustment afterward.

The scoring system explained above is not always straight-forward. In few items like general tonus, a mid level score would mean a good response and a score on

either side would be abnormal. And in few others like tremulousness, a high score would portend a bad picture while a low score means the baby is doing well. To make things straight and thereby the scores become simpler, the above scoring has been modified by Lester et al[15].

The scores are modified as follows for the selected items:

Motor

Tonus – recode: 9/1=1;8/2=2;7/3=3;4=4;6=5;5=6.

Activity – recode: 9/1=1; 8/2=2; 7/3=3; 4/6=4; 5=5.

State organization

Peak of excitement- recode: 9/1=1; 8/2=2; 5=3; 7/3=4; 6/4=5.

Irritability – recode: 9/1=1; 8=2; 7=3; 6=4; 5=5; 2/3/4=6.

Lability of state – recode: 9=1; 7/8=2; 5/6=3; 3/4=4; 1/2=5.

Autonomic system

Tremors – recode: 9=1; 8=2; 7=3; 6=4; 5=5; 4=6; 3=7; 2=8; 1=9.

Startles – recode: if 1, drop. Otherwise invert on a 8point scale. 2=8; 3=7; 4=6; 5=5; 6=4; 7=3; 8=2; 9=1.

Skin colour – recode: 1/9=1; 2/8=2; 3/7=3; 4/6=4; 5=5.

Reflexes

An abnormal score is defined as 0, 1 or 3 for all reflexes except ankle clonus, nystagmus and tonic neck reflex were 0, 1 and 2 are normal and 3 is abnormal. Reflex score = total number of abnormal reflex scores.

RESULTS

A total of 56 babies who were treated for birth asphyxia during the study period were included in the study. The babies were grouped into three HIE stages based on sarnat and sarnat[9] classification.

Frequency Table

Distribution of sample by sex

Particular	**No.of respondents (n=56)**	**Percentage (100%)**
Boy	35	62.5
Girl	21	37.5

Distribution of sample based on birth weight

Particular	**No.of respondents (n=56)**	**Percentage (100%)**
Below 2.5kg	14	25.0
Above 2.5kg	42	75.0

Distribution of sample by mode of delivery

Particular	**No.of respondents**	**Percentage**

	(n=56)	(100%)
LN	35	62.5
Forceps	12	21.4
LSCS	9	16.1

Distribution of sample by HIE staging

Particular	No.of respondents (n=56)	Percentage (100%)
HIE 1	25	44.6
HIE 2	26	46.4
HIE 3	5	8.9

The sample consisted of 35 boy babies and 21 girl babies. 25% of the sample were <2.5kg birth weight while the rest were above 2.5kgs. 62.5% of the babies were delivered by labour natural (LN), 21.4% by outlet forceps delivery and the rest 16.1% were in operation theatre by LSCS. Among the selected sample 25 babies were classified as HIE 1, 26 belonged to HIE 2 and 5 babies were HIE 3 who made it to survival.

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation

habituation (response decrement to light)	56	3	8	5.88	1.428
habituation (rattle)	56	1	8	5.71	1.942
habituation (bell)	56	0	8	5.93	2.026
habituation (foot)	56	0	8	4.71	2.230
social interactive (visual animate)	56	1	7	4.20	1.271
social interactive (visual + auditory animate)	56	2	7	4.21	1.202
social interactive (visual inanimate)	56	1	8	4.95	1.699
social interactive (visual + auditory inanimate)	56	2	7	3.89	1.397
social interactive (auditory animate)	56	1	7	4.16	1.304
social interactive (auditory inanimate)	56	2	6	3.93	.892
social interactive (alertness)	56	2	8	4.91	1.100
motor system (general tone)	56	3	6	5.54	.785
motor system (motor maturity)	56	4	8	6.32	.876
motor system (pull to sit)	56	1	7	4.11	1.344
motor system (defensive)	56	1	7	5.30	1.361
motor system (activity level)	56	3	5	4.43	.628

state organization (Peak of excitement)	56	2	5	3.91	1.049
state organization (rapidity of build up)	56	2	9	5.12	1.820
state organization (irritability)	56	2	6	4.66	1.149
state organization (lability of states)	56	2	5	3.43	.710
state regulation (cuddliness)	56	3	7	5.32	.993
state regulation (consolability)	56	2	8	4.09	1.269
state regulation (self quieting)	56	1	6	2.55	1.249
state regulation (hand to mouth)	56	1	6	2.48	1.160
autonomic system (tremulousness)	56	7	9	8.61	.562
autonomic system (startles)	56	0	8	5.41	3.622
autonomic system (lability of skin colour)	56	5	5	5.00	.000
autonomic system (smiles)	56	0	9	6.59	4.022
supplementary items (quality of alertness)	56	2	6	4.23	.914
supplementary items (cost of attention)	56	4	8	6.18	.993
supplementary items (examiner facilitation)	56	2	8	5.20	1.102

supplementary items (general irritability)	56	2	8	4.96	1.061
supplementary items (robustness/endurance)	56	3	9	6.00	.972
supplementary items (state regulation)	56	1	8	5.75	1.268
supplementary items (examiner's emotional response)	56	2	7	5.11	1.201
reflexes (plantar grasp)	56	0	2	1.61	.593
reflexes (babinski)	56	1	2	1.80	.401
reflexes (ankle clonus)	56	0	1	.50	.505
reflexes (rooting)	56	1	2	1.93	.260
reflexes (sucking)	56	1	2	1.96	.187
reflexes (glabella)	56	1	2	1.98	.134
reflexes (passive resisteance - legs)	56	1	2	1.86	.353
reflexes (passive resistance - arms)	56	0	2	1.84	.417
reflexes (palmar grasp)	56	1	2	1.64	.483
reflexes (placing)	56	1	2	1.68	.471
reflexes (standing)	56	0	2	1.41	.565
reflexes (walking)	56	0	2	1.25	.513

reflexes (crawling)	56	0	2	1.32	.543
reflexes (incurvation)	56	0	2	1.46	.538
reflexes (tonic deviation head/eyes)	56	0	2	1.30	.570
reflexes (nystagmus)	56	0	2	.73	.486
reflexes (tonic neck reflex)	56	.00	1.00	.5893	.49642
reflexes (moro)	56	1	2	1.93	.260
%score	56	38	71	59.68	7.993
reflex score	56	1	14	4.73	2.666
Valid N (listwise)	56				

NBAS consists of a total of 53 parameters. The mean and standard Deviation of each of the parameter observed is mentioned in the table above.

Chi-Square Tests

	q9.HIE stage								**Statistical inference**
	HIE 1		**HIE 2**		**HIE 3**		**Total**		
	(n=25)	***(100%)***	***(n=26)***	***(100%)***	***(n=5)***	***(100%)***	***(n=56)***	***(100%)***	
sex									
Boy	18	72.0%	12	46.2%	5	100.0%	35	62.5%	X^2=6.927 Df=2 .031<0.05 Significant
Girl	7	28.0%	14	53.8%	0	.0%	21	37.5%	

birth wt									
Below 2.5kg	8	32.0%	5	19.2%	1	20.0%	14	25.0%	X^2=1.182 Df=2 .554>0.05 Not Significant
Above 2.5kg	17	68.0%	21	80.8%	4	80.0%	42	75.0%	
MOD									
LN	16	64.0%	18	69.2%	1	20.0%	35	62.5%	X^2=5.637 Df=4 .228>0.05 Not Significant
Forceps	5	20.0%	4	15.4%	3	60.0%	12	21.4%	
LSCS	4	16.0%	4	15.4%	1	20.0%	9	16.1%	

Birth weight of the babies and the mode of delivery did not show any statistical significance correlating them with the HIE staging.

Oneway ANOVA

Stages	**Mean**	**S.D**	**SS**	**Df**	**MS**	**Statistical inference**
habituation (response decrement to light)						
Between Groups			12.825	2	6.413	F=3.423 .040<0.05 Significant
HIE 1 (n=25)	6.40	1.041				
HIE 2 (n=26)	5.50	1.530				
HIE 3 (n=5)	5.20	1.924				
Within Groups			99.300	53	1.874	
habituation (rattle)						
Between Groups			55.667	2	27.834	F=9.720

HIE 1 (n=25)	6.80	1.472				.000<0.05
HIE 2 (n=26)	4.96	1.800				Significant
HIE 3 (n=5)	4.20	2.168				
Within Groups			151.762	53	2.863	
habituation (bell)						
Between Groups			44.420	2	22.210	
HIE 1 (n=25)	6.92	1.754				F=6.493
HIE 2 (n=26)	5.12	1.883				.003<0.05
HIE 3 (n=5)	5.20	2.168				Significant
Within Groups			181.294	53	3.421	
habituation (foot)						
Between Groups			18.842	2	9.421	
HIE 1 (n=25)	5.28	2.208				F=1.961
HIE 2 (n=26)	4.42	2.212				.151>0.05
HIE 3 (n=5)	3.40	1.949				Not Significant
Within Groups			254.586	53	4.804	
social interactive (visual animate)						
Between Groups			28.518	2	14.259	
HIE 1 (n=25)	4.76	1.332				F=12.528
HIE 2 (n=26)	4.04	.720				.000<0.05
HIE 3 (n=5)	2.20	1.095				Significant
Within Groups			60.322	53	1.138	
social interactive (visual + auditory animate)						
Between Groups			26.935	2	13.467	F=13.597
HIE 1 (n=25)	4.88	1.269				.000<0.05

HIE 2 (n=26)	3.88	.711				Significant
HIE 3 (n=5)	2.60	.548				
Within Groups			52.494	53	.990	
social interactive (visual inanimate)						
Between Groups			61.299	2	30.650	
HIE 1 (n=25)	5.92	1.412				F=16.654
HIE 2 (n=26)	4.50	1.241				.000<0.05
HIE 3 (n=5)	2.40	1.673				Significant
Within Groups			97.540	53	1.840	
social interactive (visual + auditory inanimate)						
Between Groups			17.282	2	8.641	
HIE 1 (n=25)	4.36	1.524				F=5.084
HIE 2 (n=26)	3.73	1.151				.010<0.05
HIE 3 (n=5)	2.40	.548				Significant
Within Groups			90.075	53	1.700	
social interactive (auditory animate)						
Between Groups			22.914	2	11.457	
HIE 1 (n=25)	4.68	1.069				F=8.596
HIE 2 (n=26)	4.00	1.233				.001<0.05
HIE 3 (n=5)	2.40	1.140				Significant
Within Groups			70.640	53	1.333	
social interactive (auditory inanimate)						
Between Groups			4.416	2	2.208	F=2.978
HIE 1 (n=25)	4.24	.926				.059>0.05

HIE 2 (n=26)	3.69	.788				Not Significant
HIE 3 (n=5)	3.60	.894				
Within Groups			39.298	53	.741	
social interactive (alertness)						
Between Groups			35.869	2	17.934	
HIE 1 (n=25)	5.60	.707				F=30.977
HIE 2 (n=26)	4.65	.797				.000<0.05
HIE 3 (n=5)	2.80	.837				Significant
Within Groups			30.685	53	.579	
motor system (general tone)						
Between Groups			21.742	2	10.871	
HIE 1 (n=25)	5.88	.332				F=47.281
HIE 2 (n=26)	5.58	.578				.000<0.05
HIE 3 (n=5)	3.60	.548				Significant
Within Groups			12.186	53	.230	
motor system (motor maturity)						
Between Groups			12.828	2	6.414	
HIE 1 (n=25)	6.52	.653				F=11.568
HIE 2 (n=26)	6.42	.809				.000<0.05
HIE 3 (n=5)	4.80	.837				Significant
Within Groups			29.386	53	.554	
motor system (pull to sit)						
Between Groups			30.279	2	15.139	F=11.616
HIE 1 (n=25)	4.48	1.046				.000<0.05
HIE 2 (n=26)	4.19	1.297				Significant

HIE 3 (n=5)	1.80	.447				
Within Groups			69.078	53	1.303	
motor system (defensive)						
Between Groups			64.115	2	32.057	
HIE 1 (n=25)	5.92	.702				F=45.038
HIE 2 (n=26)	5.35	.892				.000<0.05
HIE 3 (n=5)	2.00	1.225				Significant
Within Groups			37.725	53	.712	
motor system (activity level)						
Between Groups			4.870	2	2.435	
HIE 1 (n=25)	4.36	.569				F=7.661
HIE 2 (n=26)	4.65	.485				.001<0.05
HIE 3 (n=5)	3.60	.894				Significant
Within Groups			16.845	53	.318	
state organization (Peak of excitement)						
Between Groups			2.467	2	1.234	
HIE 1 (n=25)	3.68	1.108				F=1.126
HIE 2 (n=26)	4.08	.935				.332>0.05
HIE 3 (n=5)	4.20	1.304				Not Significant
Within Groups			58.086	53	1.096	
state organization (rapidity of build up)						
Between Groups			.111	2	.056	F=.016
HIE 1 (n=25)	5.16	1.818				.984>0.05
HIE 2 (n=26)	5.12	1.796				Not Significant
HIE 3 (n=5)	5.00	2.345				

Within Groups			182.014	53	3.434	
state organization (irritability)						
Between Groups			9.894	2	4.947	
HIE 1 (n=25)	5.04	1.098				F=4.184
HIE 2 (n=26)	4.50	1.105				.021<0.05
HIE 3 (n=5)	3.60	.894				Significant
Within Groups			62.660	53	1.182	
state organization (lability of states)						
Between Groups			.414	2	.207	
HIE 1 (n=25)	3.40	.816				F=.402
HIE 2 (n=26)	3.50	.583				.671>0.05
HIE 3 (n=5)	3.20	.837				Significant
Within Groups			27.300	53	.515	
state regulation (cuddliness)						
Between Groups			25.616	2	12.808	
HIE 1 (n=25)	5.84	.800				F=23.736
HIE 2 (n=26)	5.19	.694				.000<0.05
HIE 3 (n=5)	3.40	.548				Significant
Within Groups			28.598	53	.540	
state regulation (consol ability)						
Between Groups			10.147	2	5.074	F=3.430
HIE 1 (n=25)	4.36	1.578				.040<0.05
HIE 2 (n=26)	4.08	.796				Significant
HIE 3 (n=5)	2.80	.837				

Within Groups			78.406	53	1.479	
state regulation (self quieting)						
Between Groups			16.418	2	8.209	
HIE 1 (n=25)	2.96	1.457				F=6.267
HIE 2 (n=26)	2.46	.859				.004<0.05
HIE 3 (n=5)	1.00	.000				Significant
Within Groups			69.422	53	1.310	
state regulation (hand to mouth)						
Between Groups			20.407	2	10.203	
HIE 1 (n=25)	3.04	1.399				F=10.094
HIE 2 (n=26)	2.23	.514				.000<0.05
HIE 3 (n=5)	1.00	.000				Significant
Within Groups			53.575	53	1.011	
autonomic system (tremulousness)						
Between Groups			2.242	2	1.121	
HIE 1 (n=25)	8.60	.577				F=3.930
HIE 2 (n=26)	8.73	.452				.026<0.05
HIE 3 (n=5)	8.00	.707				Significant
Within Groups			15.115	53	.285	
autonomic system (startles)						
Between Groups			37.638	2	18.819	F=1.458
HIE 1 (n=25)	5.60	3.582				.242>0.05
HIE 2 (n=26)	5.73	3.562				Not Significant
HIE 3 (n=5)	2.80	3.834				

Within Groups			683.915	53	12.904	
autonomic system (lability of skin colour)						
Between Groups			.000	2	.000	
HIE 1 (n=25)	5.00	.000				
HIE 2 (n=26)	5.00	.000				Nil
HIE 3 (n=5)	5.00	.000				
Within Groups			.000	53	.000	
autonomic system (smiles)						
Between Groups			261.367	2	130.684	
HIE 1 (n=25)	7.92	2.985				F=11.026
HIE 2 (n=26)	6.58	4.071				.000<0.05
HIE 3 (n=5)	.00	.000				Significant
Within Groups			628.186	53	11.853	
supplementary items (quality of alertness)						
Between Groups			16.744	2	8.372	
HIE 1 (n=25)	4.60	.707				F=15.175
HIE 2 (n=26)	4.19	.801				.000<0.05
HIE 3 (n=5)	2.60	.548				Significant
Within Groups			29.238	53	.552	
supplementary items (cost of attention)						
Between Groups			11.093	2	5.546	F=6.817
HIE 1 (n=25)	6.56	.651				.002<0.05
HIE 2 (n=26)	6.04	1.076				Significant
HIE 3 (n=5)	5.00	1.000				

Within Groups			43.122	53	.814	
supplementary items (examiner facilitation)						
Between Groups			7.145	2	3.573	F=3.172 .050>0.05 Not Significant
HIE 1 (n=25)	5.48	.918				
HIE 2 (n=26)	5.12	1.243				
HIE 3 (n=5)	4.20	.447				
Within Groups			59.694	53	1.126	
supplementary items (general irritability)						
Between Groups			9.553	2	4.777	F=4.834 .012<0.05 Significant
HIE 1 (n=25)	5.36	1.186				
HIE 2 (n=26)	4.77	.710				
HIE 3 (n=5)	4.00	1.225				
Within Groups			52.375	53	.988	
supplementary items (robustness/endurance)						
Between Groups			14.122	2	7.061	F=9.880 .000<0.05 Significant
HIE 1 (n=25)	6.12	.726				
HIE 2 (n=26)	6.19	.895				
HIE 3 (n=5)	4.40	1.140				
Within Groups			37.878	53	.715	
supplementary items (state regulation)						
Between Groups			17.514	2	8.757	F=6.538 .003<0.05 Significant
HIE 1 (n=25)	6.32	.557				
HIE 2 (n=26)	5.42	1.501				
HIE 3 (n=5)	4.60	1.342				

Within Groups			70.986	53	1.339	
supplementary items (examiner's emotional response)						
Between Groups			51.019	2	25.509	
HIE 1 (n=25)	6.00	.707				F=47.709
HIE 2 (n=26)	4.69	.736				.000<0.05
HIE 3 (n=5)	2.80	.837				Significant
Within Groups			28.338	53	.535	
reflexes (plantar grasp)						
Between Groups			6.451	2	3.225	
HIE 1 (n=25)	1.84	.374				F=13.246
HIE 2 (n=26)	1.58	.504				.000<0.05
HIE 3 (n=5)	.60	.894				Significant
Within Groups			12.906	53	.244	
reflexes (babinski)						
Between Groups			2.464	2	1.232	
HIE 1 (n=25)	1.96	.200				F=10.241
HIE 2 (n=26)	1.77	.430				.000<0.05
HIE 3 (n=5)	1.20	.447				Significant
Within Groups			6.375	53	.120	
reflexes (ankle clonus)						
Between Groups			1.500	2	.750	
HIE 1 (n=25)	.60	.500				F=3.180
HIE 2 (n=26)	.50	.510				.050>0.05
HIE 3 (n=5)	.00	.000				Not Significant
Within Groups			12.500	53	.236	

reflexes (rooting)						
Between Groups			1.554	2	.777	
HIE 1 (n=25)	1.96	.200				F=19.069
HIE 2 (n=26)	2.00	.000				.000<0.05
HIE 3 (n=5)	1.40	.548				Significant
Within Groups			2.160	53	.041	
reflexes (sucking)						
Between Groups			.729	2	.364	
HIE 1 (n=25)	2.00	.000				F=16.089
HIE 2 (n=26)	2.00	.000				.000<0.05
HIE 3 (n=5)	1.60	.548				Significant
Within Groups			1.200	53	.023	
reflexes (glabella)						
Between Groups			.182	2	.091	
HIE 1 (n=25)	2.00	.000				F=6.033
HIE 2 (n=26)	2.00	.000				.004<0.05
HIE 3 (n=5)	1.80	.447				Significant
Within Groups			.800	53	.015	
reflexes (passive resisteance - legs)						
Between Groups			2.371	2	1.185	
HIE 1 (n=25)	1.92	.277				F=14.006
HIE 2 (n=26)	1.92	.272				.000<0.05
HIE 3 (n=5)	1.20	.447				Significant
Within Groups			4.486	53	.085	
reflexes (passive resistance - arms)						

Between Groups			5.947	2	2.974	
HIE 1 (n=25)	1.96	.200				F=43.705
HIE 2 (n=26)	1.92	.272				.000<0.05
HIE 3 (n=5)	.80	.447				Significant
Within Groups			3.606	53	.068	
reflexes (palmar grasp)						
Between Groups			3.151	2	1.575	
HIE 1 (n=25)	1.84	.374				F=8.603
HIE 2 (n=26)	1.58	.504				.001<0.05
HIE 3 (n=5)	1.00	.000				Significant
Within Groups			9.706	53	.183	
reflexes (placing)						
Between Groups			.436	2	.218	
HIE 1 (n=25)	1.72	.458				F=.981
HIE 2 (n=26)	1.69	.471				.382>0.05
HIE 3 (n=5)	1.40	.548				Not Significant
Within Groups			11.778	53	.222	
reflexes (standing)						
Between Groups			2.167	2	1.084	
HIE 1 (n=25)	1.52	.510				F=3.733
HIE 2 (n=26)	1.42	.504				.030<0.05
HIE 3 (n=5)	.80	.837				Significant
Within Groups			15.386	53	.290	
reflexes (walking)						
Between Groups			1.145	2	.572	F=2.271
HIE 1 (n=25)	1.32	.476				.113>0.05

HIE 2 (n=26)	1.27	.452				Not Significant
HIE 3 (n=5)	.80	.837				
Within Groups			13.355	53	.252	
reflexes (crawling)						
Between Groups			1.716	2	.858	F=3.136 .052>0.05 Not Significant
HIE 1 (n=25)	1.44	.507				
HIE 2 (n=26)	1.31	.471				
HIE 3 (n=5)	.80	.837				
Within Groups			14.498	53	.274	
reflexes (incurvation)						
Between Groups			1.227	2	.614	F=2.212 .120>0.05 Not Significant
HIE 1 (n=25)	1.48	.510				
HIE 2 (n=26)	1.54	.508				
HIE 3 (n=5)	1.00	.707				
Within Groups			14.702	53	.277	
reflexes (tonic deviation head/eyes)						
Between Groups			.164	2	.082	F=.246 .783>0.05 Not Significant
HIE 1 (n=25)	1.36	.638				
HIE 2 (n=26)	1.27	.452				
HIE 3 (n=5)	1.20	.837				
Within Groups			17.675	53	.333	
reflexes (nystagmus)						
Between Groups			.704	2	.352	F=1.519 .228>0.05
HIE 1 (n=25)	.72	.458				
HIE 2 (n=26)	.81	.491				

HIE 3 (n=5)	.40	.548				Not Significant
Within Groups			12.278	53	.232	
reflexes (tonic neck reflex)						
Between Groups			.869	2	.434	F=1.815 .173>0.05 Not Significant
HIE 1 (n=25)	.6000	.50000				
HIE 2 (n=26)	.6538	.48516				
HIE 3 (n=5)	.2000	.44721				
Within Groups			12.685	53	.239	
reflexes (moro)						
Between Groups			2.914	2	1.457	F=96.536 .000<0.05 Significant
HIE 1 (n=25)	2.00	.000				
HIE 2 (n=26)	2.00	.000				
HIE 3 (n=5)	1.20	.447				
Within Groups			.800	53	.015	
%score						
Between Groups			2389.753	2	1194.876	F=56.322 .000<0.05 Significant
HIE 1 (n=25)	65.01	5.287				
HIE 2 (n=26)	58.01	3.757				
HIE 3 (n=5)	41.75	5.016				
Within Groups			1124.406	53	21.215	
reflex score						
Between Groups			192.667	2	96.333	F=25.745 .000<0.05 Significant
HIE 1 (n=25)	3.60	1.683				
HIE 2 (n=26)	4.73	1.663				
HIE 3 (n=5)	10.40	3.912				
Within Groups			198.315	53	3.742	

Among the behavioral items, statistical significance for difference among HIE stages was seen in all parameters observed except in response decrement to tactile stimulation of the foot, auditory inanimate orientation, peak excitement, rapidity of build up and startles. Among the supplementary items except for examiner facilitation all other items showed a statistical significance for the differences observed between the HIE stages.

The final percentage scores were calculated using the Lester's modification. The average score of HIE 1 babies were 65.01%, HIE 2 babies were 58.01% and that of HIE 3 babies were 41.75%. The differences were statistically significant as shown in the table above.

Eight of the eighteen reflex items did not show statistical significance for the differences observed. However the final abnormal reflex score marked using Lester's modification showed a statistically significant difference between the HIE stages.

Frequency distribution of the observed values

%score

Particulars	**Frequency (n=56)**	**Percent (100%)**

Below 39.99	3	5.4
40 to 49.99	3	5.4
50 to 59.99	21	37.5
60 to 69.99	28	50.0
70 & above	1	1.8

50% of the sample had a final score between 60 and 70% and another 37.5% of the sample scored between 50 and 60%. The remaining few fell on the either sides.

Abnormal Reflex score

Particulars	**Frequency (n=56)**	**Percent (100%)**
Below 5	42	75.0
6 to 10	11	19.6
11 & above	3	5.4

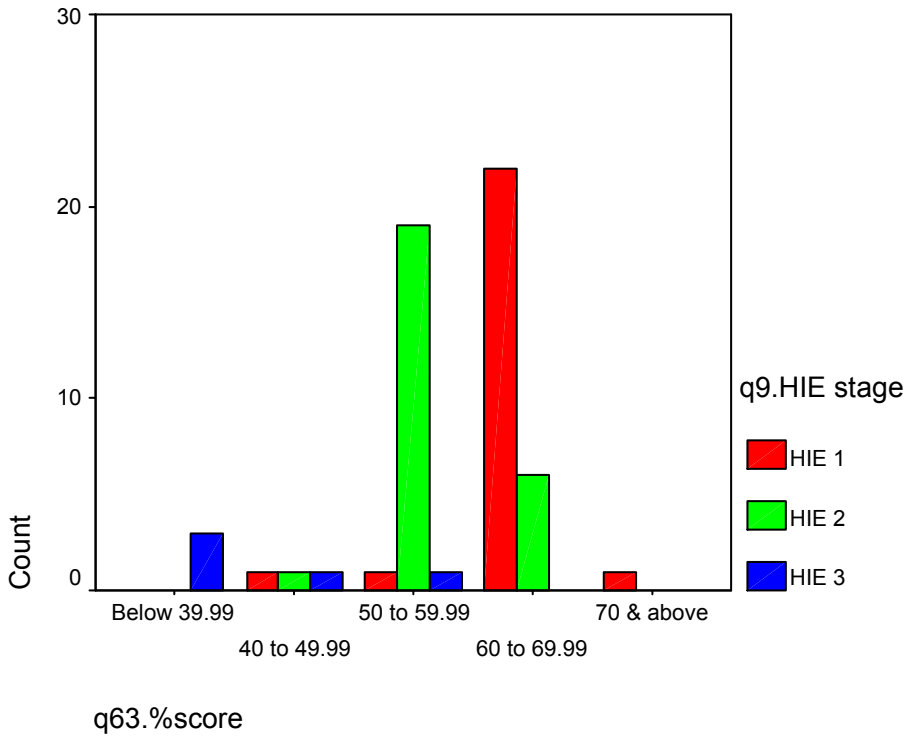
75% of the selected babies had an abnormal reflex score below 5 and 5% had score above 11. The rest were between the two cut-offs as shown in the table above.

Chi-square test

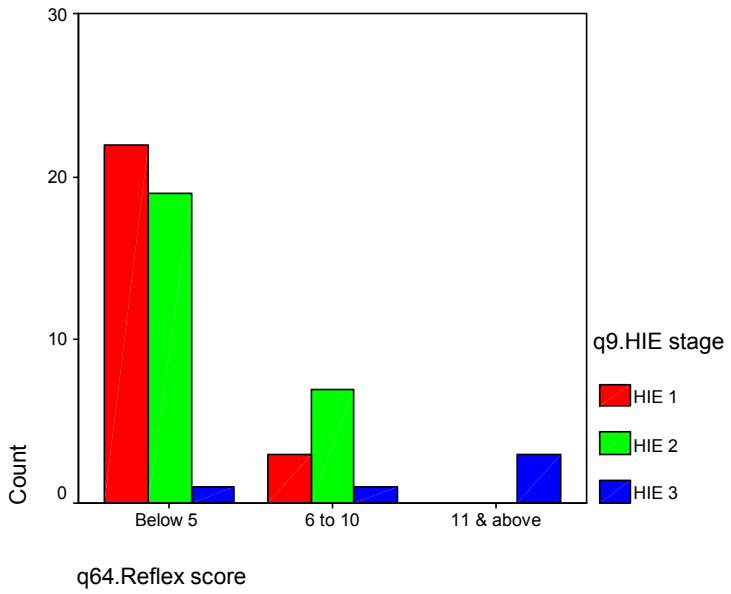
	HIE 1		**HIE 2**		**HIE 3**		**Total**		**Statistical inference**
	(n=25)	***(100%)***	***(n=26)***	***(100%)***	***(n=5)***	***(100%)***	***(n=56)***	***(100%)***	
%score									
Below 39.99	0	.0%	0	.0%	3	60.0%	3	5.4%	X^2=64.193 Df=8 .000<0.05 Significant
40 to 49.99	1	4.0%	1	3.8%	1	20.0%	3	5.4%	
50 to 59.99	1	4.0%	19	73.1%	1	20.0%	21	37.5%	
60 to 69.99	22	88.0%	6	23.1%	0	.0%	28	50.0%	
70 & above	1	4.0%	0	.0%	0	.0%	1	1.8%	
Reflex score									
Below 5	22	88.0%	19	73.1%	1	20.0%	42	75.0%	X^2=34.638 Df=4 .000<0.05 Significant
6 to 10	3	12.0%	7	26.9%	1	20.0%	11	19.6%	
11 & above	0	.0%	0	.0%	3	60.0%	3	5.4%	

60% of HIE 3 babies made a score less than 40%. 73% of HIE 2 babies scored between 50 and 60%. 88% of HIE 1 babies scored between 60 and 70%. These values are statistically significant as shown above.

Final %score Vs HIE stage :-



Abnormal reflex score Vs HIE stage



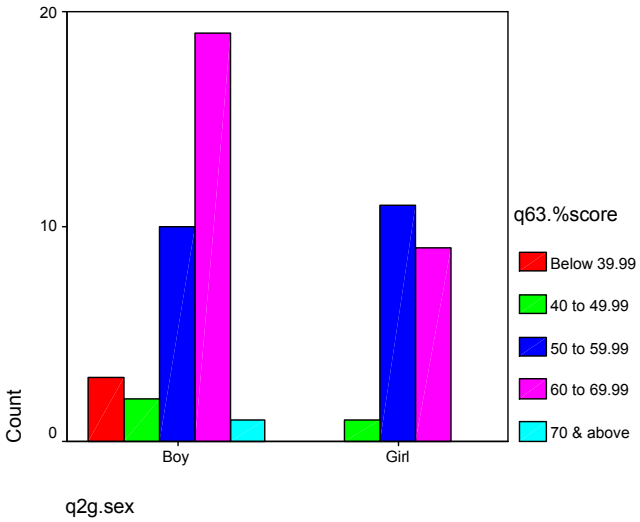
Chi-square test

	%score												Statistical inference
	Below 39.99		40 to 49.99		50 to 59.99		60 to 69.99		70 & above		Total		
	(n=3)	(100%)	(n=3)	(100%)	(n=21)	(100%)	(n=28)	(100%)	(n=1)	(100%)	(n=56)	(100%)	
Sex													
Boy	3	100.0%	2	66.7%	10	47.6%	19	67.9%	1	100.0%	35	62.5%	X^2=4.749 Df=4 .314>0.05 Not Significant
Girl	0	.0%	1	33.3%	11	52.4%	9	32.1%	0	.0%	21	37.5%	
Birth wt													
Below 2.5kg	1	33.3%	0	.0%	5	23.8%	7	25.0%	1	100.0%	14	25.0%	X^2=4.127 Df=4 .389>0.05 Not Significant
Above 2.5kg	2	66.7%	3	100.0%	16	76.2%	21	75.0%	0	.0%	42	75.0%	
MOD													
LN	0	.0%	1	33.3%	13	61.9%	21	75.0%	0	.0%	35	62.5%	X^2=16.313 Df=8
Forceps	2	66.7%	2	66.7%	4	19.0%	4	14.3%	0	.0%	12	21.4%	

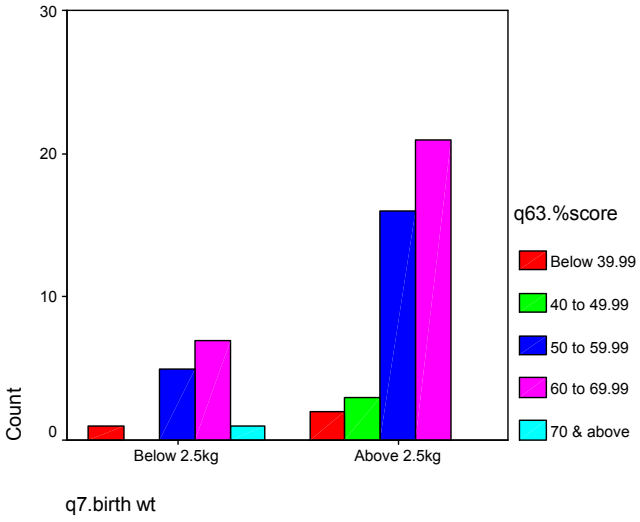
LSCS	1	33.3%	0	.0%	4	19.0%	3	10.7%	1	100.0%	9	16.1%	.038<0.05 Significant
HIE stage													
HIE 1	0	.0%	1	33.3%	1	4.8%	22	78.6%	1	100.0%	25	44.6%	X^2=64.193 Df=8 .000<0.05 Significant
HIE 2	0	.0%	1	33.3%	19	90.5%	6	21.4%	0	.0%	26	46.4%	
HIE 3	3	100.0%	1	33.3%	1	4.8%	0	.0%	0	.0%	5	8.9%	

Sex of the babies, their birth weight and the mode of delivery showed no statistical significance for comparing them against the final % scores. However as already mentioned, the HIE staging and their final %scores were statistically significant.

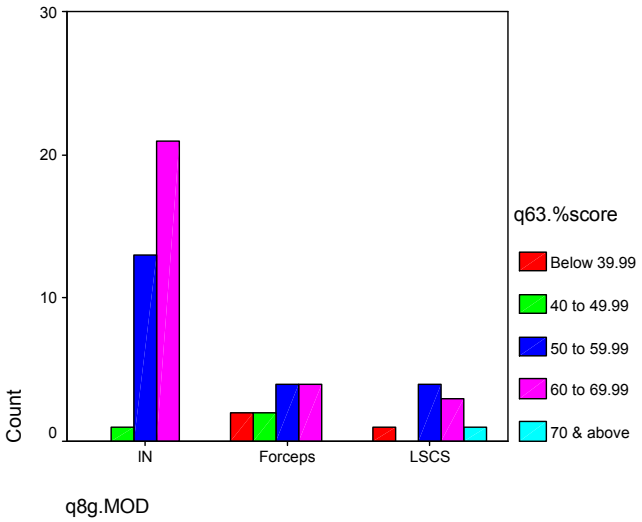
Sex of the babies Vs their final %scores: - not significant



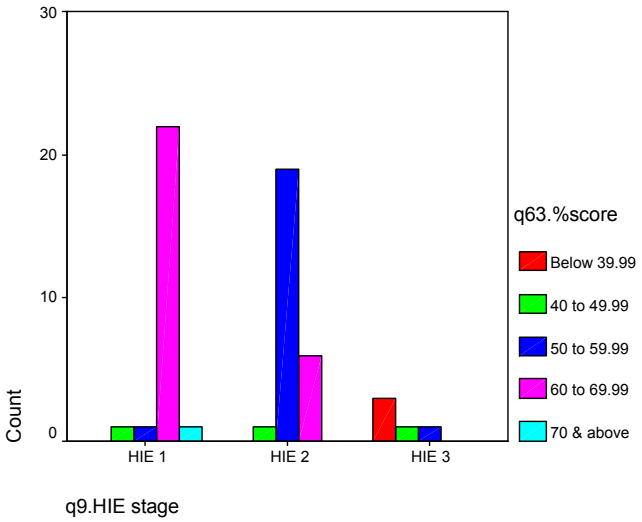
Birth weight Vs final% scores: - not significant



Mode of delivery Vs final %score: - not significant



HIE staging Vs final % score: - statistically significant

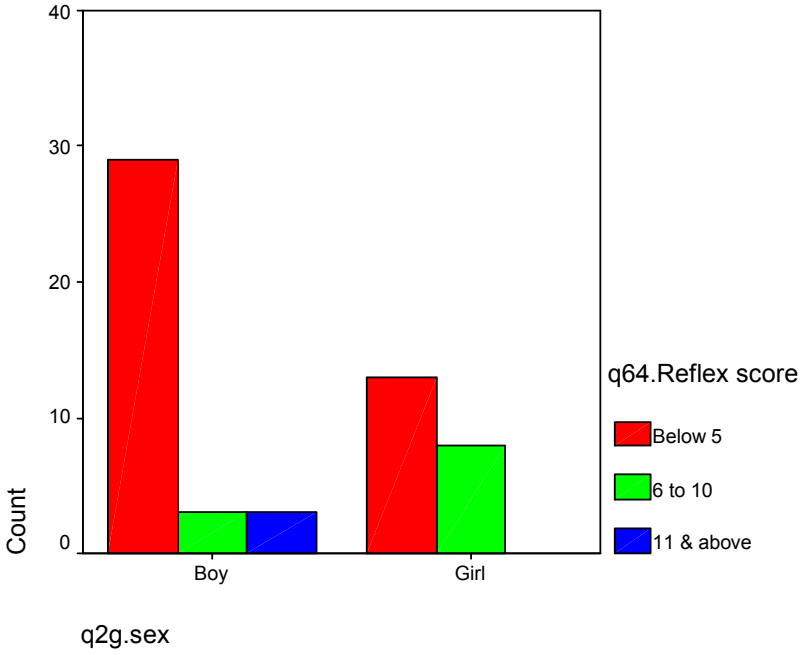


Chi-square test

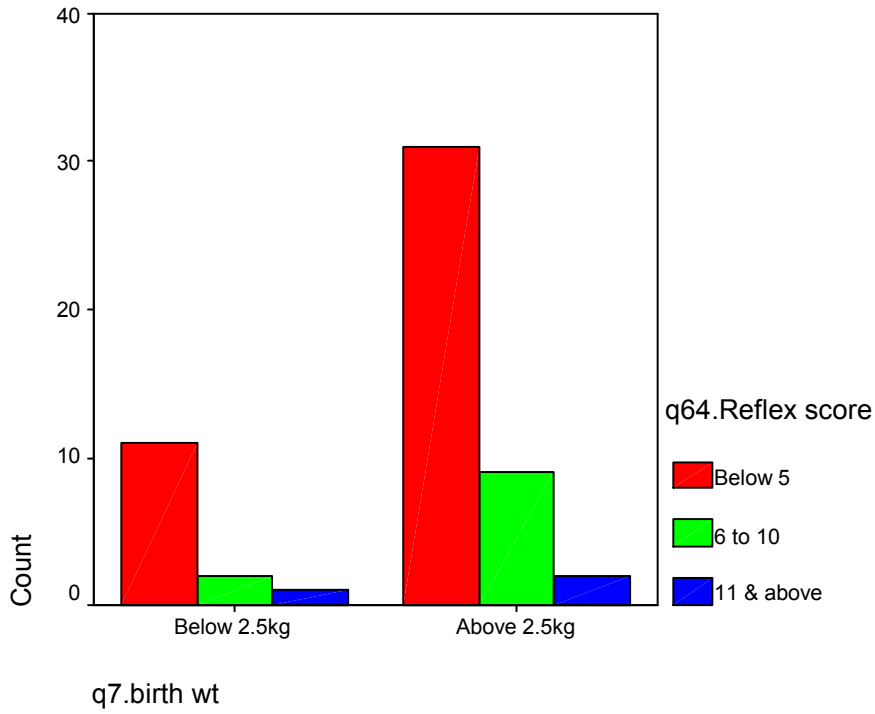
			Reflex score						
	Below 5		**6 to 10**		**11 & above**		**Total**		**Statistical inference**
	(n=42)	***(100%)***	***(n=11)***	***(100%)***	***(n=3)***	***(100%)***	***(n=56)***	***(100%)***	
Sex									
Boy	29	69.0%	3	27.3%	3	100.0%	35	62.5%	X^2=8.392 Df=2 .015<0.05 Significant
Girl	13	31.0%	8	72.7%	0	.0%	21	37.5%	
Birth wt									
Below 2.5kg	11	26.2%	2	18.2%	1	33.3%	14	25.0%	X^2=0.416 Df=2 .812>0.05 Not Significant
Above 2.5kg	31	73.8%	9	81.8%	2	66.7%	42	75.0%	
MOD									
LN	27	64.3%	8	72.7%	0	.0%	35	62.5%	X^2=6.010 Df=4 .198>0.05 Not Significant
Forceps	8	19.0%	2	18.2%	2	66.7%	12	21.4%	
LSCS	7	16.7%	1	9.1%	1	33.3%	9	16.1%	
HIE stage									
HIE 1	22	52.4%	3	27.3%	0	.0%	25	44.6%	X^2=34.638 Df=4 .000<0.05 Significant
HIE 2	19	45.2%	7	63.6%	0	.0%	26	46.4%	
HIE 3	1	2.4%	1	9.1%	3	100.0%	5	8.9%	

As already mentioned, there is statistically significant difference between the HIE stages and the abnormal reflex scores observed. >50% of HIE 1 babies had abnormal reflex score less than 5 while >60% of HIE 2 babies scored between 6 and 10. HIE 3 were the worst to perform where 3 of 5 babies scored >11.

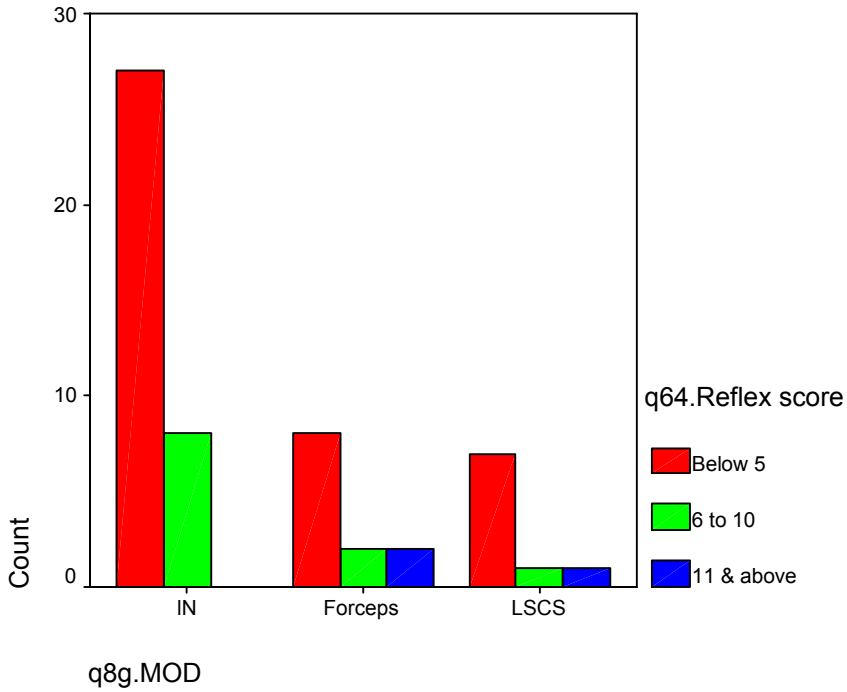
Sex Vs abnormal Reflex score: - clinically not significant



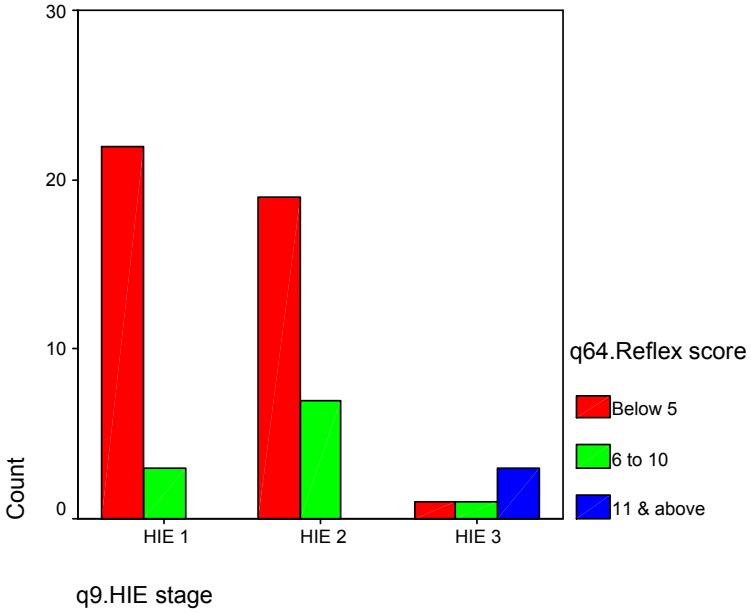
Birth wt Vs abnormal Reflex scores: - not significant



Mode of delivery Vs abnormal Reflex score: - not significant



HIE stage Vs abnormal Reflex score: - statistically significant

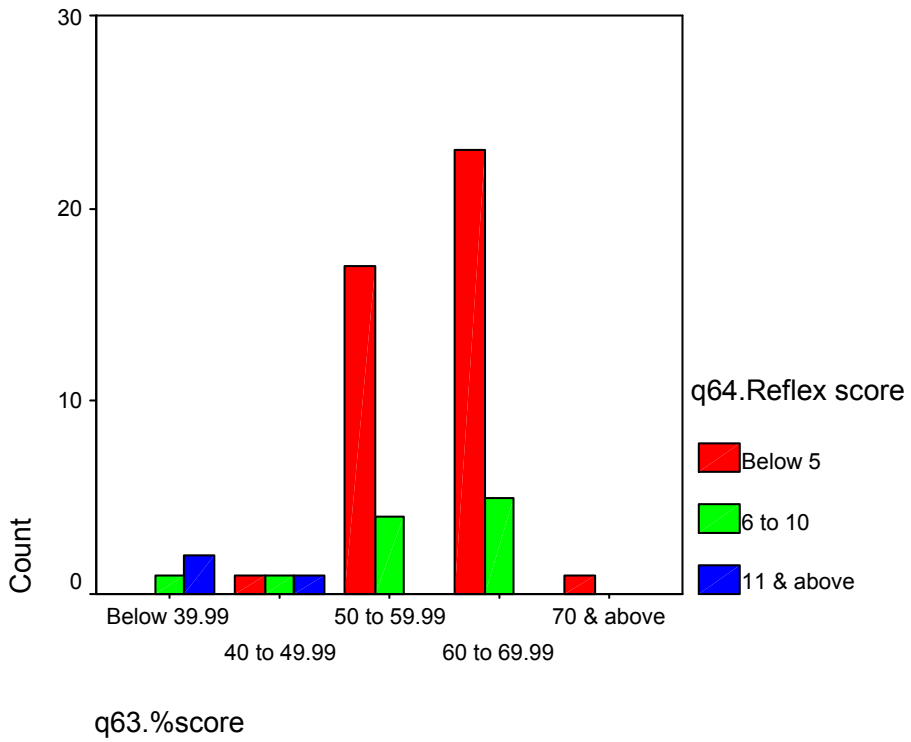


%score * Reflex score

%score	**Reflex score**				Statistical inference
	Below 5 (n=42)	**6 to 10 (n=11)**	**11 & above (n=3)**	**Total (n=56)**	
Below 39.99	0	1(9.1%)	2(66.7%)	3(5.4%)	X^2=32.247 Df=8 .000<0.05 Significant
40 to 49.99	1(2.4%)	1(9.1%)	1(33.3%)	3(5.4%)	
50 to 59.99	17(40.5%)	4(36.4%)	0	21(37.5%)	
60 to 69.99	23(54.8%)	5(45.5%)	0	28(50%)	
70 & above	1(2.4%)	0	0	1(1.8%)	

Lower final %scores were associated with higher abnormal reflex scores and vice-versa. The association was statistically significant.

Chart



SUMMARY

- 56 babies who survived birth asphyxia were randomly selected during the study period (march 2015 – august 2015) and included in the study.
- Babies with associated co-morbidities like prematurity, sepsis, anomalies were excluded.
- The selected babies were grouped as HIE stage 1, 2, and 3 based on sarnat and sarnat[9] staging
- The sample consisted of 35 boy babies and 21 girl babies. Of the total 56, 25 were labelled as HIE 1, 26 as HIE 2 and jus 5 as HIE 3.
- When these babies were deemed fit for discharge from hospital, NBAS was administered on them in the presence of the mother and scores calculated.

- The average score of HIE 1 babies were 65.01%, HIE 2 babies were 58.01% and that of HIE 3 babies were 41.75%.
- 60% of HIE 3 babies made a score less than 40%. 73% of HIE 2 babies scored between 50 and 60%. 88% of HIE 1 babies scored between 60 and 70%.
- >50% of HIE 1 babies had abnormal reflex score less than 5 while >60% of HIE 2 babies scored between 6 and 10. HIE 3 were the worst to perform where 3 of 5 babies scored >11.
- Sex of the babies, their birth weight and the mode of delivery showed no statistical significance for comparing them against the final % scores.
- Lower final %scores were associated with higher abnormal reflex scores and vice-versa.

CONCLUSION

- Birth asphyxia significantly puts a baby off-track in terms of their behaviour which can be very well be assessed clinically and be documented objectively using T. Berry Brazelton's NBAS(Neonatal Beavhioral Assessment Scale)
- NBAS helps us to prognostigate a baby individually rather relying on past experiences or non-directive statistics.
- When the mother receives her sick baby who has just recovered from NICU may not be confident enough to handle her baby. She may need a lot of support from the hospital team to help her take care of her baby. NBAS demonstrates the strengths of the baby. By doing so, the mother would feel more confident to handle her baby. Making the mother know her baby well eases the parent-child relationship.

- Apart from strengths, NBAS also demonstrates the weakness and areas of concerns of the baby. By identifying this, early rehabilitation and intervention becomes possible.
- In short, every birth asphyxia survivor needs to be administered NBAS before discharge from hospital. By identifying strengths, one can boost the mother's confidence in looking after her child and ease the parent-child relationship. By identifying weakness and concerns, one can refer the child for rehabilitation and further intervention as would be required.
- Limitations of the study

  - Small sample size

  - Only one time observation. A single observation of NBAS may not completely depict the behaviour of the child.

  - Due to limitation of time period, follow up study was not available. However the babies are under follow up.

  - Hardly any literature on NBAS administered on birth asphyxia babies.

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ANNEXURE

NBAS SCORING FORM

INFANT BEHAVIOR

HABITUATION	9	8	7	6	5	4	3	2	1
Response Dec.-Light									
Response Dec.-Rattle									
Response Dec.-Bell									
Response Dec.-Foot									

SOCIAL-INTERACTIVE	9	8	7	6	5	4	3	2	1
Animate Visual									
Animate Vis. +Aud.									
Inanimate Visual									
Inanimate Vis. +Aud.									
Animate Auditory									
Inanimate Auditory									
Alertness									

MOTOR SYSTEM	9	8	7	6	5	4	3	2	1
General Tone									
Motor Maturity									
Pull-to-Sit									
Defensive									
Activity Level									

STATE ORGANIZATION	9	8	7	6	5	4	3	2	1
Peak of Excitement									
Rapidity of Build-up									
Irritability									
Lability of States									

STATE REGULATION	9	8	7	6	5	4	3	2	1
Cuddliness									
Consolability									
Self-Quieting									
Hand-to-Mouth									

AUTONOMIC SYSTEM	9	8	7	6	5	4	3	2	1
Tremulousness									
Startles									
Lability of Skin Color									
smiles									

SUPPLEMENTARY ITEMS	9	8	7	6	5	4	3	2	1

Quality of Alertness									
Cost of Attention									
Examiner Facilitation									
General Irritability									
Robustness/Endurance									
State Regulation									
Examiner's Emot. Resp.									

REFLEXES	0	1	2	3	Asym
Plantar Grasp					
Babinski					
Ankle Clonus					
Rooting					
Sucking					
Glabella					
Passive Resist.- Legs					
Passive Resist.- Arms					
Palmar Grasp					

Placing					
Standing					
Walking					
Crawling					
Incurvation					
Tonic Dev. Head/Eyes					
Nystagmus					
Tonic Neck Reflex					
Moro					